89

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AN ATLAS FOR THE SOLAR AND LUNAR ORBIT PERTURBATION EFFECTS COMPUTER PROGRAM

BY

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MAY 1967

GODDARD SPACE FLIGHT CENTER

GREENBELT, MARYLAND

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TABLE OF CONTENTS

I. SUMMARY

The logic of the subroutines used by the Solar and Lunar Orbit Perturbation Effects computer program, SLOPE, along with their relationships to the main program and to each other, is presented.

II. INTRODUCTION AND EXPLANATION OF THE LOGIC CHARTS

The Solar and Lunar Orbit Perturbation Effects computer program, SLOPE, is designed so that the basic computations are performed by several subroutines. This paper presents the logic of these subroutines and describes their relationships to each other and to the main program. It is intended to be used as an aid in correlating the computations to Reference 2 and to show the logical flow of these computations.

The Common statements, Data statements and Format statements for each subroutine are presented along with a Table of Contents and Cross-Reference Listing for the subroutines. The Cross-Reference Listing show for each label in the subroutine the page and symbol number for the label itself and for all points in the flow charts at which transfers to it are found. These page numbers refer to the flow charts and are at the right uppermost corner of each flow chart. They are not to be confused with the page numbers of this paper itself. An asterisk, *, indicates that there are other transfers to a label other than the one shown.

III. MAIN PROGRAM, SATD

The main program does a minimum of computation. Its main function is to control the several computational options and to control the input and output of the program. The logic charts presented on the following pages correlate the interaction of the subroutines and the main program. (See page 2 of Reference 1.)

COLE SATD

```
      DECK SATD
      COMMON/ORB/Q(28),A,E,OI,EL,W,CW,EN,IBUG,L,M
      COMMON/DER/D(6),WD,CWD,ELD,ISEC(2),KSL
      COMMON/RAD/P(6,6),B(6,6)
      COMMON/PERT/ARG(125,2),ARGD(125,2),PAR(125,2,6),SEC(5,2)
      COMMON/COEF/C(125,5)
      COMMON/CONS/ CJ2,CJ4,AE,PLIM
      DIMENSION SAT(12),ASL(3,3),IC(5),KSL(2),PT(5),PG(5,2),TOP(5)
      DIMENSION STA(5),TERM(5)
      DIMENSION D1OUT(6,10),IC1(6,3),PARD1(6,6),FLG1(6)
      DIMENSION DUMOUT(123,13),ICD(123,5),PARDUM(123,6),FLGDUM(123),
      ITRMD(123)
      DIMENSION BLOCK(100)
      DIMENSION MESS(4,5),AS(4)
      EQUIVALENCE (DUMOUT,D1OUT)
      EQUIVALENCE (D1OUT,IC1),(D1OUT(1,4),PARD1),(D1OUT(1,10),FLG1)
      EQUIVALENCE (DUMOUT(1,1),ICD(1,1)),(PARDUM(1,1),DUMOUT(1,6)),
      (FLGDUM(1),DUMOUT(1,13)),(ITRMD(1),DUMOUT(1,12))
      EQUIVALENCE (ISEC(1),IS1),(ISEC(2),IS2)
      DATA(ASL(I,1),I = 1,3)/6HSOLAR ,6HGRAVIT,5HATION/,(ASL(I,2),I=1,3)
      /6HLUNAR ,6HGRAVIT,5HATION/ ,(ASL(I,3),I=1,3)/6HSOLAR ,6HPRESSU,
        2HRE  /
        ,TWP/6.2831853/,VUPD/107.085/,DPR/57.29578/,RPD/.0174532925/
         ,FLAG/.99999999E+30/ ,ONE/1.0/
      DATA (MESS(1,I),I=1,5)/6HPE ORB,6HIT GEN,6HERATOR,6H WAS U,3HSED/,
        (MESS(2,I),I=1,5)/6HGILL O,6HRBIT G,6HENERAT,6HOR WAS,6H USED /,
      (MESS(3,I),I=1,5)/6HBRWER ,6HORBIT ,6HGENERA,6HTOR WA,6HS USED/ ,
        (MESS(4,I),I=1,5)/6HHST OR,6HBIT GE,6HNERATO,6HR WAS ,6HUSED  /
      DATA ACUT/3HCUT/, ABLNK/3H   /
      DATA (AS(I),I=1,4) /6H      ,6HSOLAR ,6H      ,6HLUNAR /
      EQUIVALENCE(KS,KSL(1)),(KL,KSL(2))
 1000 FORMAT(12A6)
 1010 FORMAT(4E12.8)
 1020 FORMAT(4I6,F6.0)
 1030 FORMAT(3F12.6,2I6,2I3,3I6)
 1040 FORMAT(F6.0,1X,F2.0,I2,F2.0,1X,2F2.0,1X,F2.0,F3.0)
 1050 FORMAT(6E12.8)
 1100 FORMAT(F10.5,1X7I1)
 1500 FORMAT(5E14.8)
 2000 FORMAT (1H1//30X27H*****  START OF CASE  *****)
 5010 FORMAT (1H0//5X12A6/)
```

MISCELLANEOUS STATEMENTS

DECK SATD

```
5011   FORMAT (1H1,5X,12A6)

2010   FORMAT(1H05X13HEPOCH DATE ISF11.8,10H CENTURIES,20X,I2,1H/,I2,1H/,
       I2,F12.6 // 6X,21HSATELLITE HAS AREA OF E14.8,20H SQ. CM. AND MASS
        OF E11.4,6H GRAMS )

2020   FORMAT(1H010X3A6)

2030   FORMAT(1H010X3HDAY F7.2,10H OF EPOCH ///
       7X17HPERTURBING FORCES)

2040   FORMAT(1H010X29HSOLAR RADIATION PRESSURE, F =E15.8,14H CM./SEC./SE
       C.)

2050   FORMAT(///20X68HORBITAL ELEMENTS (EXCLUDING LUNAR-SOLAR PERTURBATI
       ONS AT THIS POINT)
                                          //12X1HA19X1HE19X1HI19X1HL/
       4E20.8//9X5HOMEGA16X9HCAP OMEGA13X1HN19X1HT/4E20.8//)

2080   FORMAT(1H0,6X28HARGUMENTS OF TERMS HAVE FORM//
        10X81H(N1*LAMBDA PRIME + N2*OMEGA PRIME + N3*CAP OMEGA PRIME + N4
       *OMEGA + N5*CAP OMEGA)//)

2090   FORMAT(1H012X26HINCLUDING SECULAR TERMS -   2A6  )

2100   FORMAT(26X7HDELTA E9X7HDELTA I9X7HDELTA L7X11HDELTA OMEGA
       3X15HDELTA CAP OMEGA/)

2110   FORMAT (2X14,2X5I3,6E16.8,I4,1XA3)

2120   FORMAT(11X3I3,6E16.8,1X,A3)

2200   FORMAT(1H014X5HTOTAL,5E16.8,3X,3A6 )

2210   FORMAT(1H012X7HSECULAR,5E16.8,3X,3A6 )

2300   FORMAT(1H08X11HGRAND TOTAL,5E16.8)

2310   FORMAT(9X14HN1 N2 N3 N4 N5,6X
                 7HDELTA E9X7HDELTA I9X7HDELTA L7X11HDELTA OMEGA
       3X15HDELTA CAP OMEGA,3X,6HPERIOD,6X4HTERM)

2320   FORMAT(12X8HN4 N5 N1,6X
                 7HDELTA E9X7HDELTA I9X7HDELTA L7X11HDELTA OMEGA
       3X15HDELTA CAP OMEGA,3X,6HPERIOD   )

2400   FORMAT(1H028X1HE,15X1HI,15X1HL,13X5HOMEGA,9X9HCAP OMEGA//
         20X5E16.8)

2420   FORMAT(1H0,12X,1HA,15X 1HE,15X1HI,15X1HL,13X5HOMEGA,9X9HCAP OMEGA/
       /  4X6E16.8)

2410   FORMAT (1H0,3X,16HPERTAPE ELEMENTS  5E16.8 )

2500   FORMAT(1H010X21HAMPLITUDES BY TERM -  3A6//)

2510   FORMAT(1H010X36HAMPLITUDES BY TERM - SOLAR RADIATION//)

2600   FORMAT(1H010X16HCONSTANTS - J2 =E15.8,6H, J4 =E15.8,
         14H, PER. LIMIT =E15.8/20X,16HSOLAR PRESSURE =E15.8 ,13H DYNES/S
       Q.CM.)

3000   FORMAT(1H120X12HDEBUG OUTPUT/)

3100   FORMAT(1H0,10X,20HSEMI-MAJOR AXIS, A =F12.8)

3200   FORMAT(1H0,10X,17HECCENTRICITY, E =F12.8)

3300   FORMAT(1H0,10X,48HREDUNDANCY OR END OF FILE ON BINARY ELEMENT TAPE
       )
```

DECK SATD

```
3400  FORMAT(1H0,10X,28HBINARY ELEMENT TAPE INPUT -    5A6   )
3500  FORMAT(1H0,10X,47HDELTA T OPTION MUST BE USED WITH PERTAPE OPTION)
3700  FORMAT(1H0,12X30H** WARNING - A OUT OF RANGE **//)
3900  FORMAT(1H0,12X,18H*** ERROR STOP ***)
3910  FORMAT ( 76H1  NO PERTURBATION OPTIONS SELECTED ON TIME AND PERTUR
      BATION OPTION CARD NO. I4 , 16H  - CARD IGNORED  )
3920  FORMAT (48H1  TIME ON TIME AND PERTURBATION OPTION CARD NO. I4   ,
        47H IS BEFORE TIME ON PREVIOUS CARD - CARD IGNORED  )
3930  FORMAT ( 78H1  NO PERTURBATION OPTIONS SELECTED ON PERTURBATION OP
      TION CARD - CASE IGNORED )
```

TABLE OF CONTENTS AND CROSS-REFERENCE LISTING

PAGE BOX	LABEL	REFERENCES						
DECK SATD								
1.06	10	2.33	3.14	9.02	9.05			
1.24	301	1.18						
1.29	302	1.35						
1.32		2.04						
1.33	15	1.23						
1.36	11	1.32	1.32	1.32	1.32	1.32	1.32	1.32
1.37	13	1.32	1.32	1.32	1.32			
2.01	14	1.32						
2.04	16	1.36	1.37	2.02				
2.06	17	1.30						
2.10		2.12						
2.11	5015							
2.15	18	2.28						
2.25	900	2.14						
2.29	910	2.15						
2.33	27							
3.01	28	2.32						
3.09	330							
3.09	20	2.23	3.02					
3.10		8.34						
3.15	21							
3.16	22							
3.18	23	3.15						
3.19	24							
3.21	25	3.18						
4.01	350	3.10						
4.04	360	3.21	4.02					
4.11		4.08						
4.14		4.11						
4.17		4.14						
4.20		4.17						
4.27		4.25						
4.30		5.03						
4.33		4.34						
4.34	40							

TABLE OF CONTENTS AND CROSS-REFERENCE LISTING

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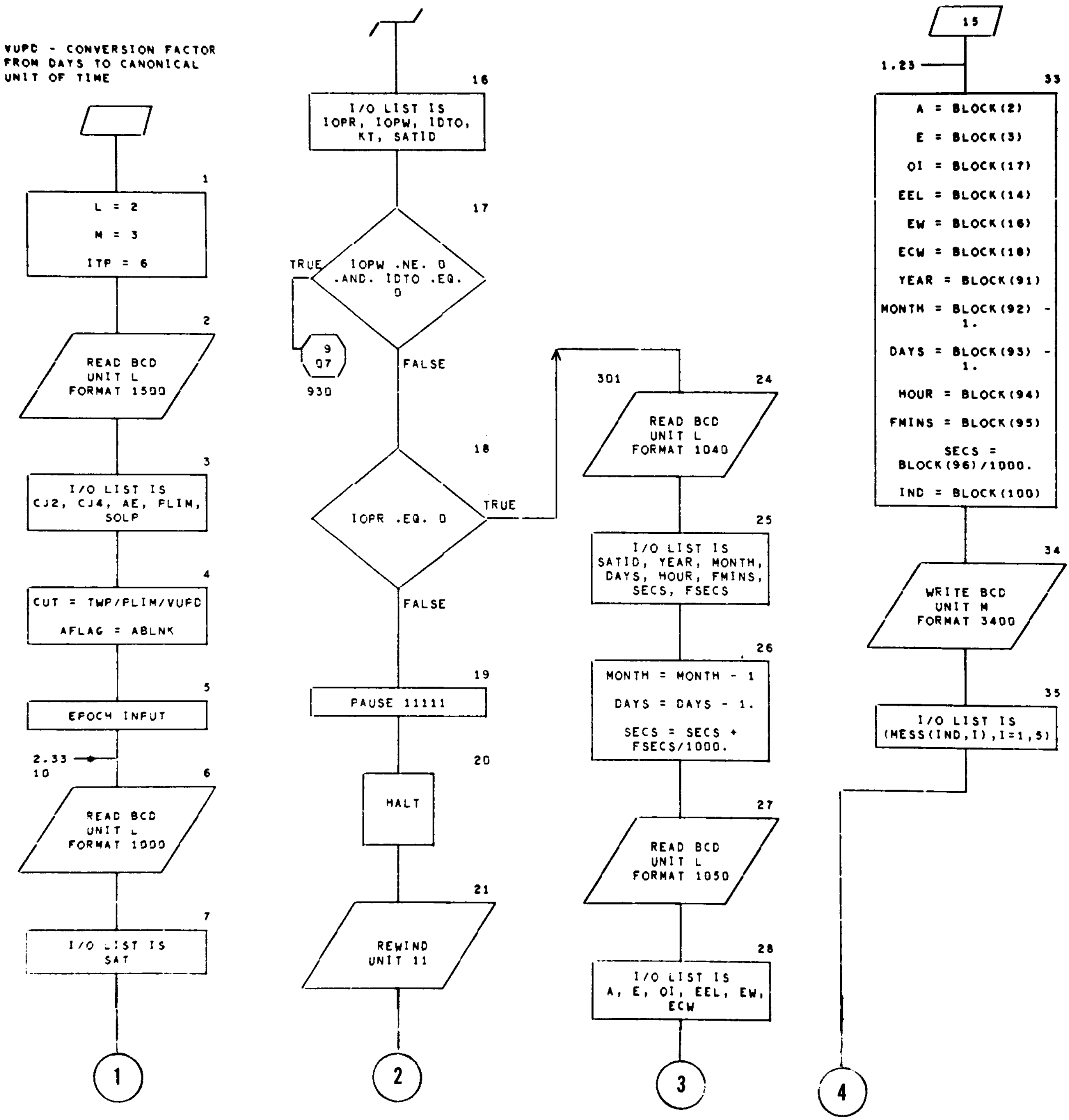
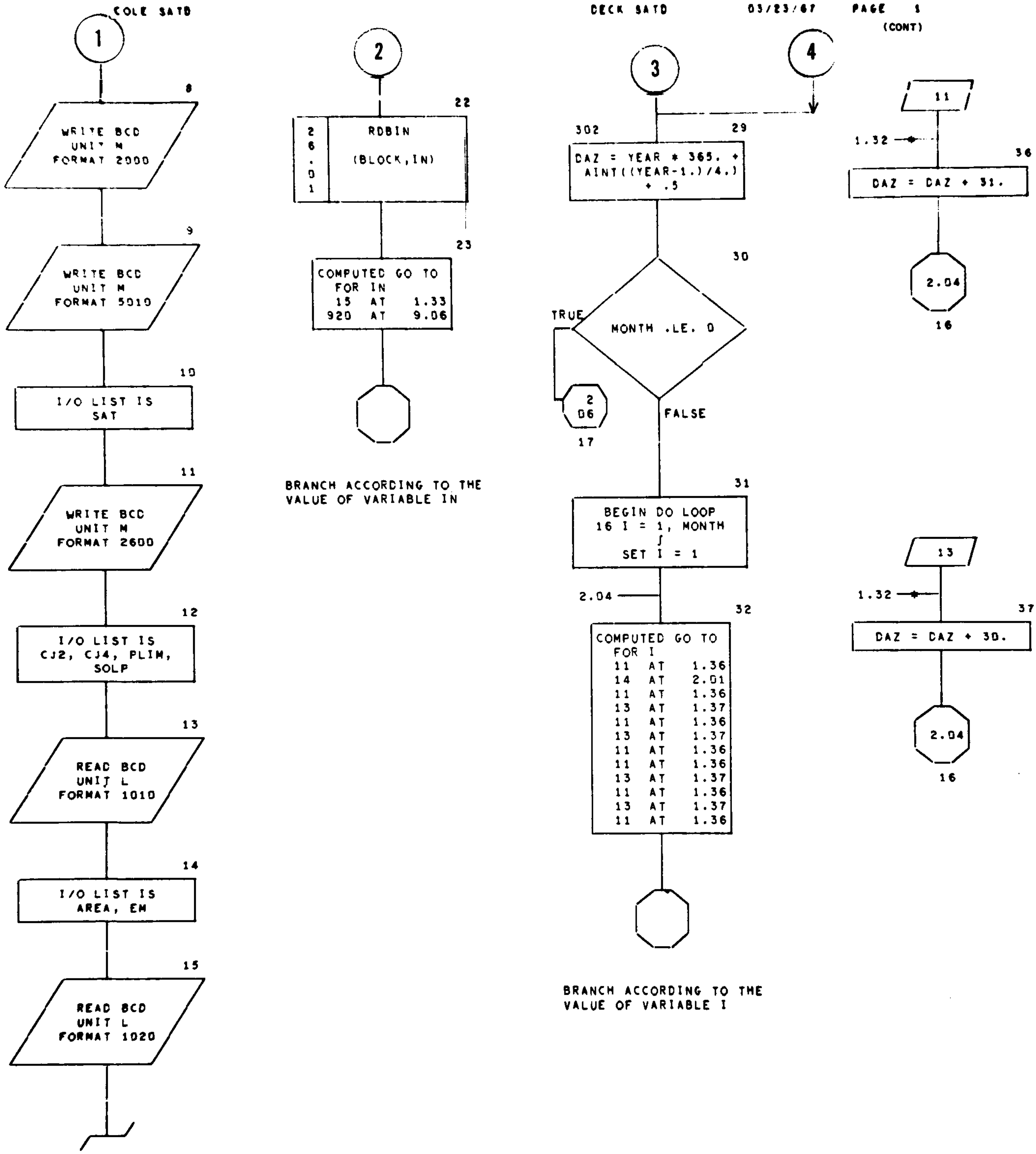
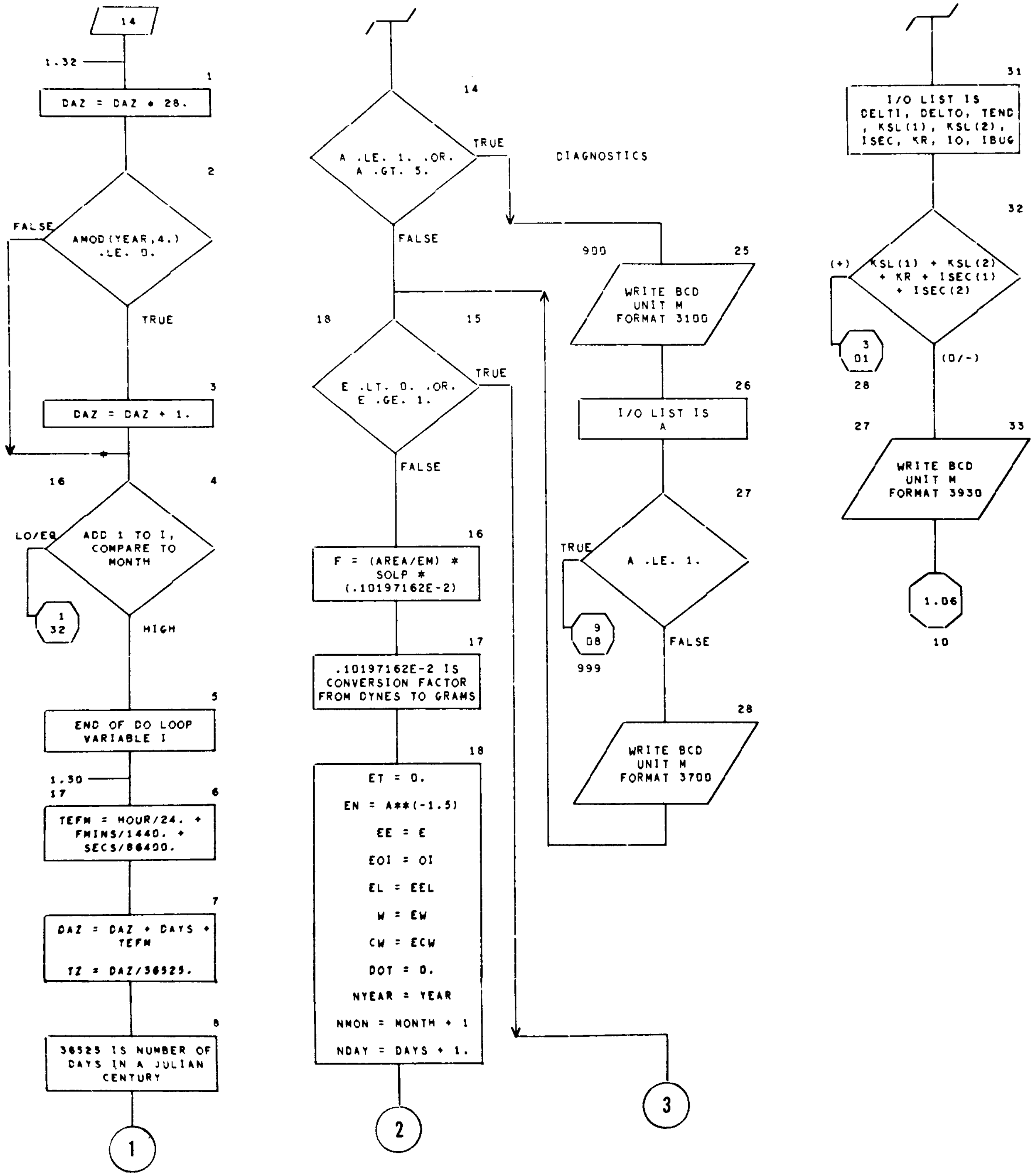
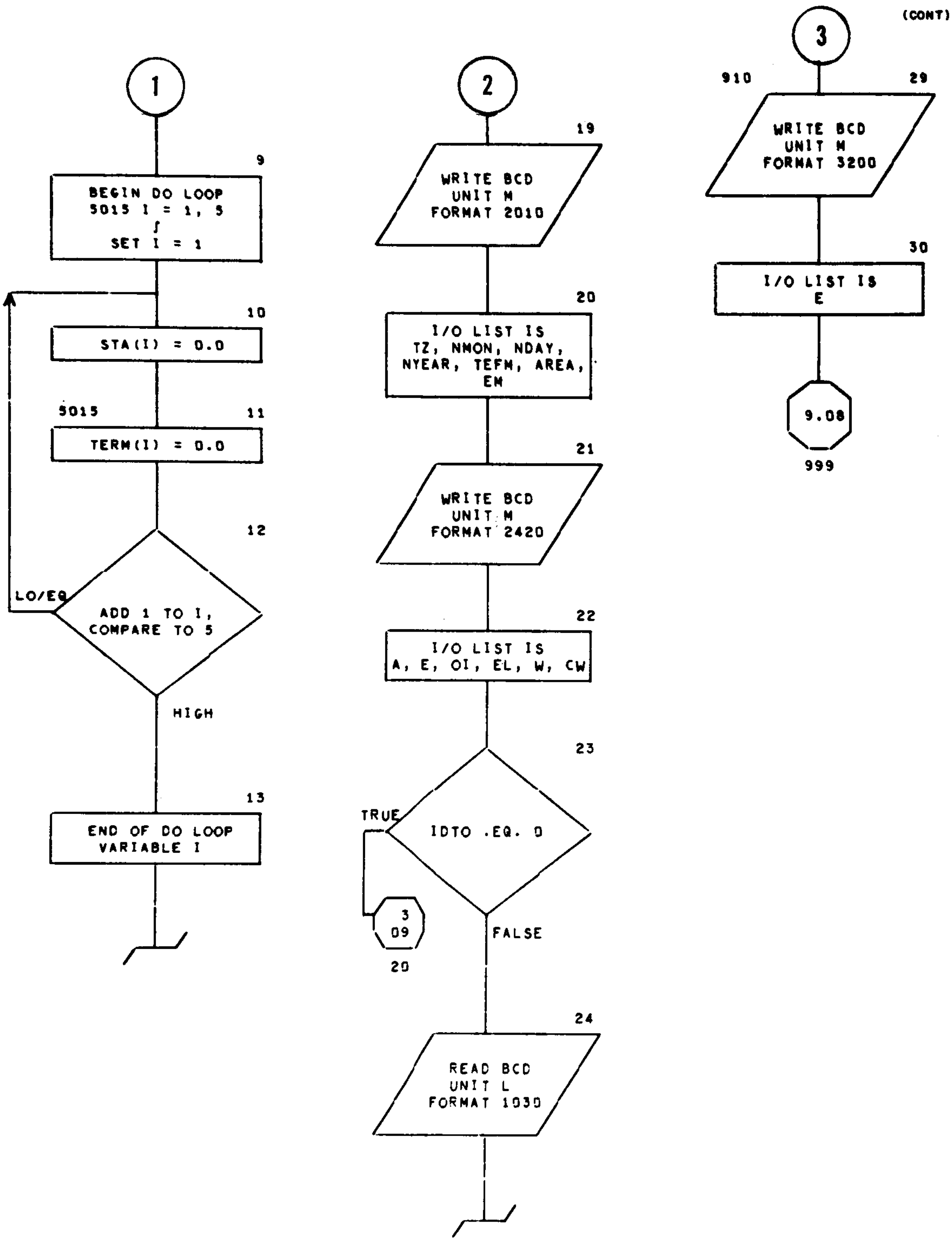
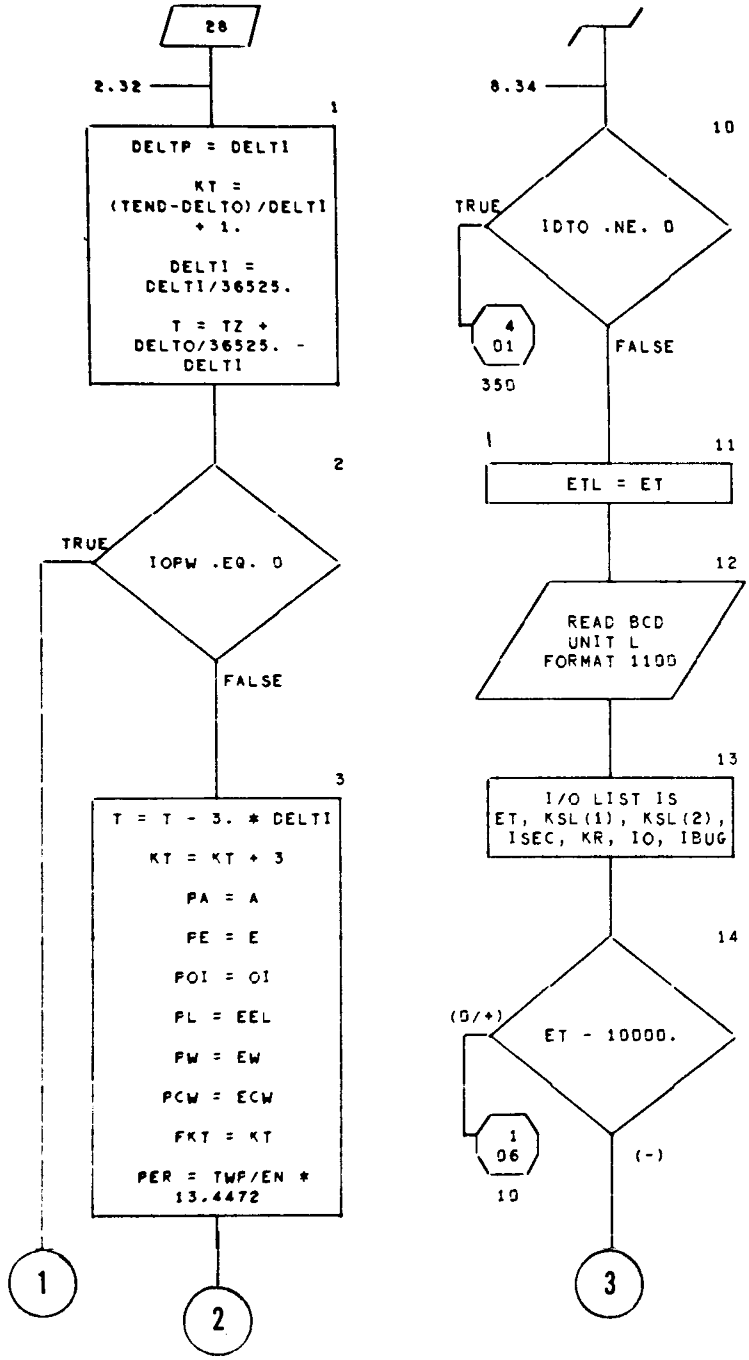
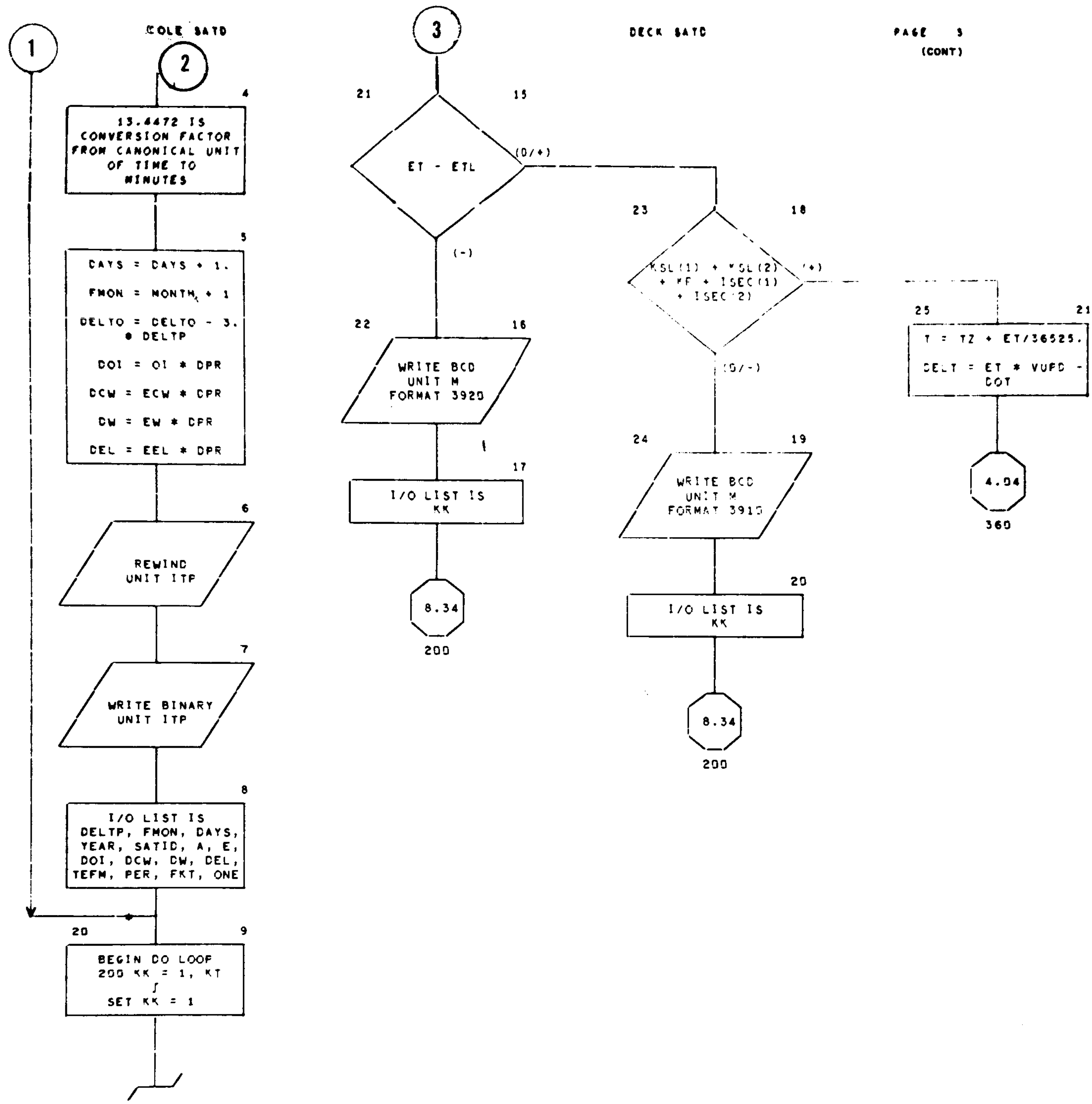

VUPD - CONVERSION FACTOR
FROM DAYS TO CANONICAL
UNIT OF TIME
1
L = 2
M = 3
ITP = 6
2
READ BCD
UNIT L
FORMAT 1500
3
I/O LIST IS
CJ2, CJ4, AE, FLIM,
SOLP
4
CUT = TWP/FLIM/VUPD
AFLAG = ABLNK
5
EPOCH INPUT
2.33
10
6
READ BCD
UNIT L
FORMAT 1000
7
I/O LIST IS
SAT
1
16
I/O LIST IS
IOPR, IOPW, IDTO,
KT, SATID
17
IOPW .NE. 0
.AND. IDTO .EQ.
0
TRUE
9
07
930
FALSE
18
IOPR .EQ. 0
TRUE
FALSE
19
PAUSE 11111
20
HALT
21
REWIND
UNIT 11
2
301
24
READ BCD
UNIT L
FORMAT 1040
25
I/O LIST IS
SATID, YEAR, MONTH,
DAYS, HOUR, FMINS,
SECS, FSECS
26
MONTH = MONTH - 1
DAYS = DAYS - 1.
SECS = SECS +
FSECS/1000.
27
READ BCD
UNIT L
FORMAT 1050
28
I/O LIST IS
A, E, OI, EEL, EW,
ECW
3
15
1.23
33
A = BLOCK(2)
E = BLOCK(3)
OI = BLOCK(17)
EEL = BLOCK(14)
EW = BLOCK(16)
ECW = BLOCK(18)
YEAR = BLOCK(91)
MONTH = BLOCK(92) -
1.
DAYS = BLOCK(93) -
1.
HOUR = BLOCK(94)
FMINS = BLOCK(95)
SECS =
BLOCK(96)/1000.
IND = BLOCK(100)
34
WRITE BCD
UNIT M
FORMAT 3400
35
I/O LIST IS
(MESS(IND,I),I=1,5)
4

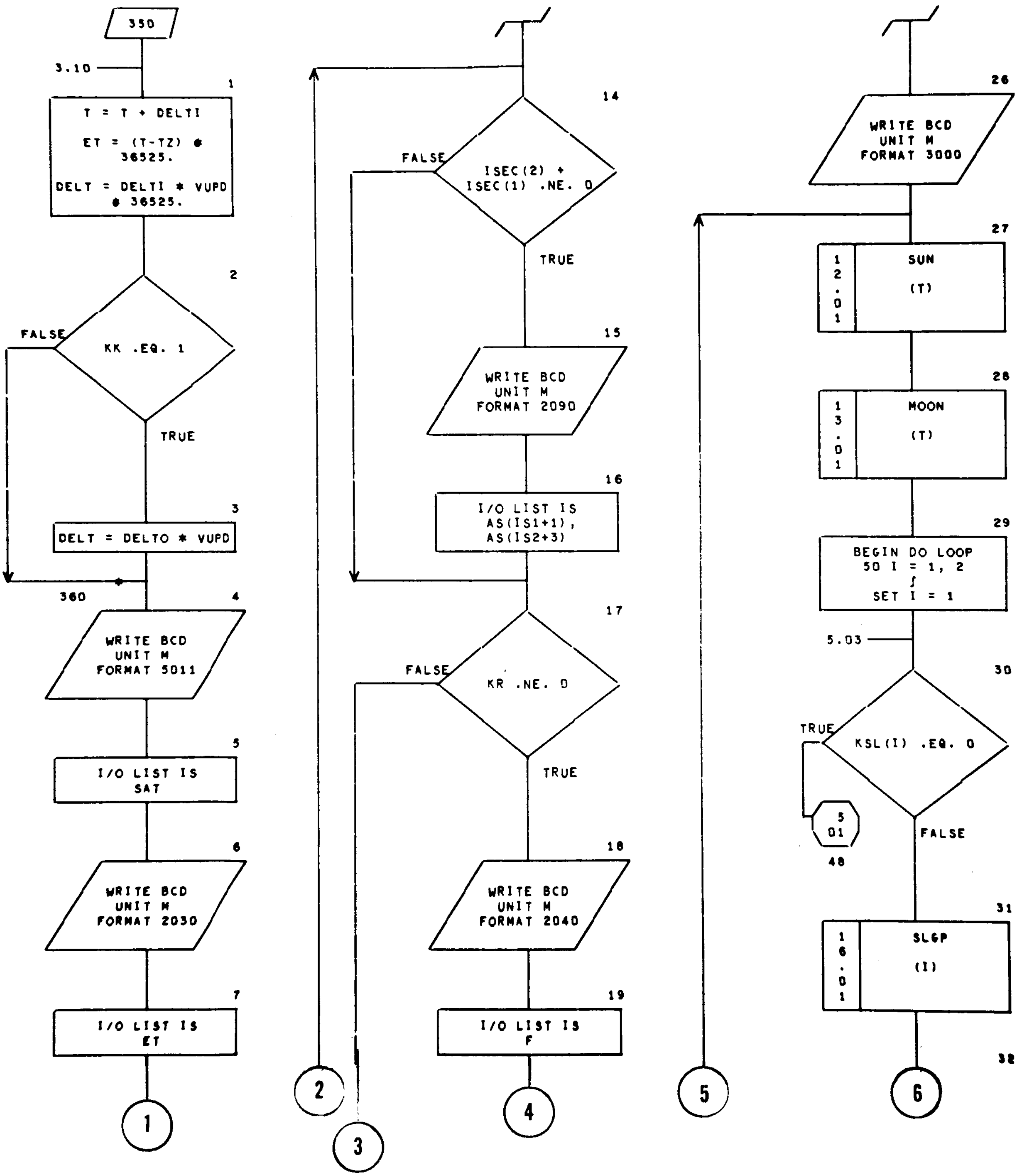

COLE SATB
DECK SATD
03/23/67
PAGE 1
(CONT)
1
8
WRITE BCD
UNIT M
FORMAT 2000
9
WRITE BCD
UNIT M
FORMAT 5010
10
I/O LIST IS
SAT
11
WRITE BCD
UNIT M
FORMAT 2600
12
I/O LIST IS
CJ2, CJ4, PLIM,
SOLP
13
READ BCD
UNIT L
FORMAT 1010
14
I/O LIST IS
AREA, EM
15
READ BCD
UNIT L
FORMAT 1020
2
22
2
6
.
0
1
RDBIN
(BLOCK,IN)
23
COMPUTED GO TO
FOR IN
15 AT 1.33
920 AT 9.06
BRANCH ACCORDING TO THE
VALUE OF VARIABLE IN
3
4
302
29
DAZ = YEAR * 365. +
AINT((YEAR-1.)/4.)
+ .5
30
MONTH .LE. 0
TRUE
2
06
17
FALSE
31
BEGIN DO LOOP
16 I = 1, MONTH
SET I = 1
2.04
32
COMPUTED GO TO
FOR I
11 AT 1.36
14 AT 2.01
11 AT 1.36
13 AT 1.37
11 AT 1.36
13 AT 1.37
11 AT 1.36
11 AT 1.36
13 AT 1.37
11 AT 1.36
13 AT 1.37
11 AT 1.36
BRANCH ACCORDING TO THE
VALUE OF VARIABLE I
11
1.32
36
DAZ = DAZ + 31.
2.04
16
13
1.32
37
DAZ = DAZ + 30.
2.04
16

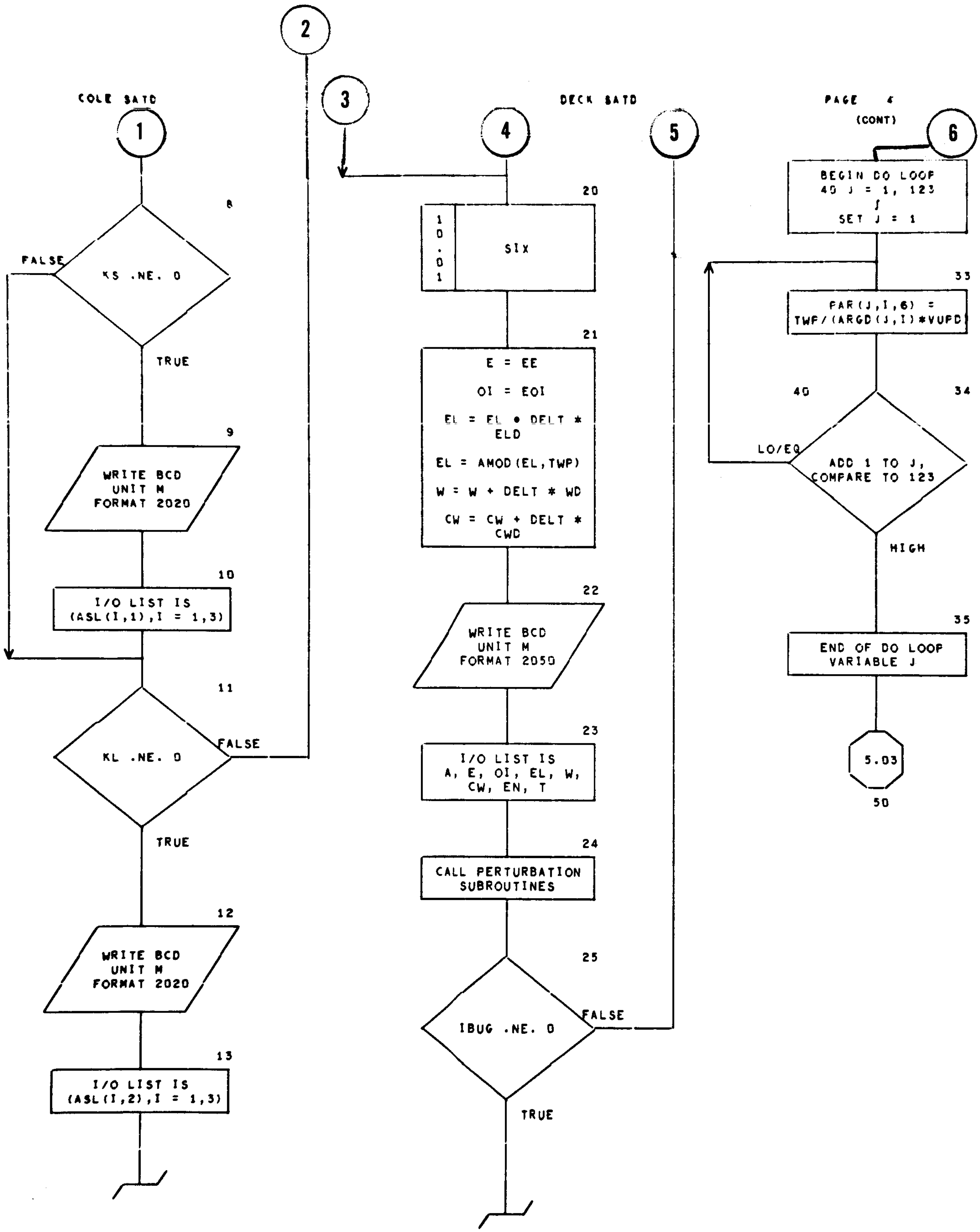

14
1.32
DAZ = DAZ + 28.
FALSE
AMOD(YEAR,4.) .LE. 0.
TRUE
DAZ = DAZ + 1.
LO/EQ
ADD 1 TO I, COMPARE TO MONTH
HIGH
END OF DO LOOP VARIABLE I
1.30
TEFM = HOUR/24. + FMINS/1440. + SECS/86400.
DAZ = DAZ + DAYS + TEFM
TZ = DAZ/36525.
36525 IS NUMBER OF DAYS IN A JULIAN CENTURY
A .LE. 1. .OR. A .GT. 5.
TRUE
FALSE
E .LT. 0. .OR. E .GE. 1.
F = (AREA/EM) * SOLP * (.10197162E-2)
.10197162E-2 IS CONVERSION FACTOR FROM DYNES TO GRAMS
ET = 0.
EN = A**(-1.5)
EE = E
EOI = OI
EL = EEL
W = EW
CW = ECW
DOT = 0.
NYEAR = YEAR
NMON = MONTH + 1
NDAY = DAYS + 1.
DIAGNOSTICS
WRITE BCD UNIT M FORMAT 3100
I/O LIST IS A
A .LE. 1.
WRITE BCD UNIT M FORMAT 3700
I/O LIST IS DELTI, DELTO, TEND, KSL(1), KSL(2), ISEC, KR, IO, IBUG
KSL(1) + KSL(2) + KR + ISEC(1) + ISEC(2)
(+)
(0/-)
WRITE BCD UNIT M FORMAT 3930
1.06


1
9
BEGIN DO LOOP
5015 I = 1, 5
SET I = 1
10
STA(I) = 0.0
5015
11
TERM(I) = 0.0
12
LO/EQ
ADD 1 TO I, COMPARE TO 5
HIGH
13
END OF DO LOOP VARIABLE I
2
19
WRITE BCD UNIT M FORMAT 2010
20
I/O LIST IS TZ, NMON, NDAY, NYEAR, TEFM, AREA, EM
21
WRITE BCD UNIT M FORMAT 2420
22
I/O LIST IS A, E, OI, EL, W, CW
23
TRUE
IDTO .EQ. 0
3
09
20
FALSE
24
READ BCD UNIT L FORMAT 1030
3
910
29
WRITE BCD UNIT M FORMAT 3200
30
I/O LIST IS E
9.08
999

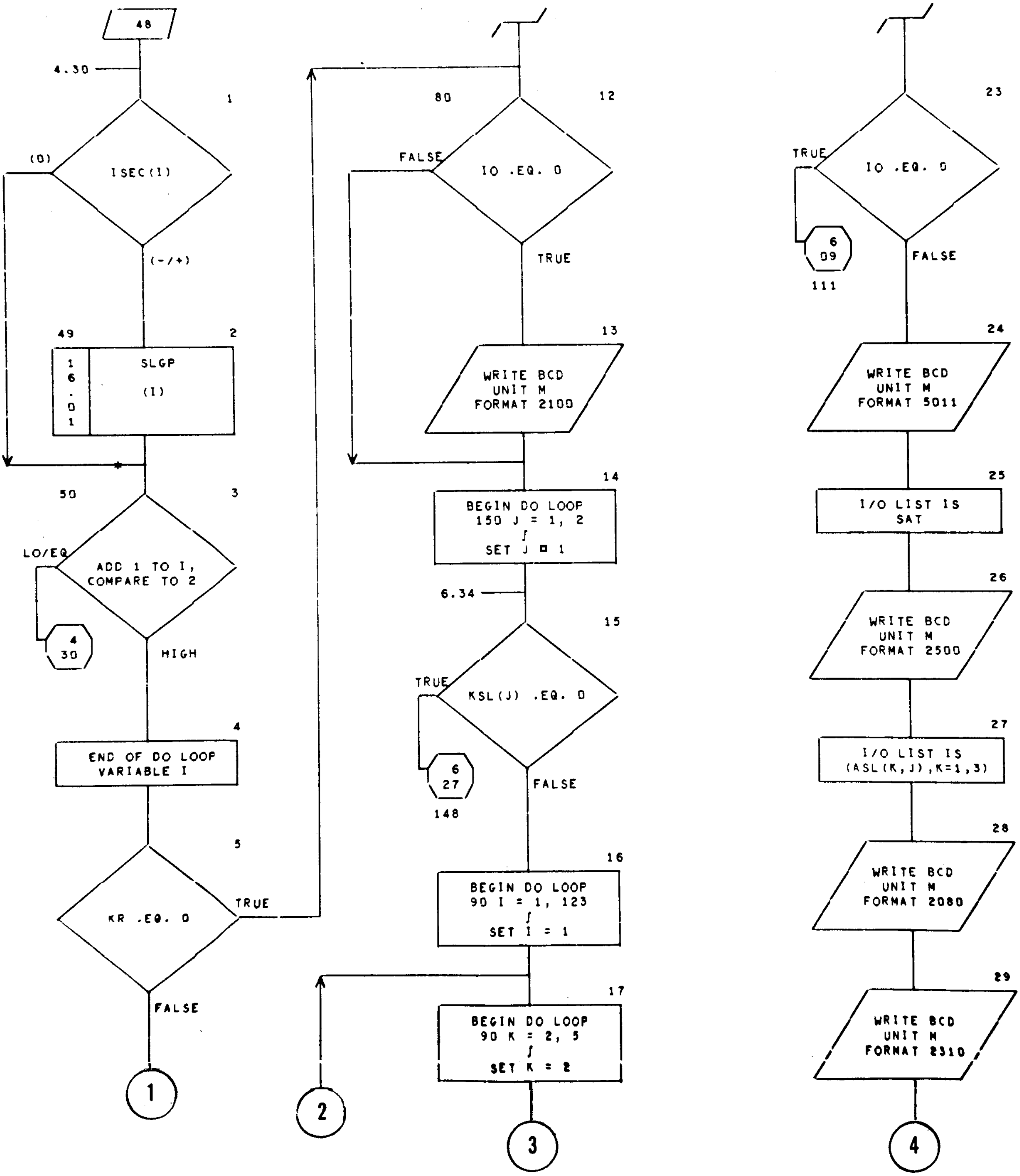

28
2.32
1
DELTP = DELTI
KT = (TEND-DELTO)/DELTI + 1.
DELTI = DELTI/36525.
T = TZ + DELTO/36525. - DELTI
2
TRUE
IOPW .EQ. 0
FALSE
3
T = T - 3. * DELTI
KT = KT + 3
PA = A
PE = E
POI = OI
PL = EEL
PW = EW
PCW = ECW
FKT = KT
PER = TWP/EN * 13.4472
1
2
8.34
10
TRUE
IDTO .NE. 0
4
01
350
FALSE
11
ETL = ET
12
READ BCD
UNIT L
FORMAT 1100
13
I/O LIST IS
ET, KSL(1), KSL(2),
ISEC, KR, IO, IBUG
14
(0/+)
ET - 10000.
1
06
10
(-)
3

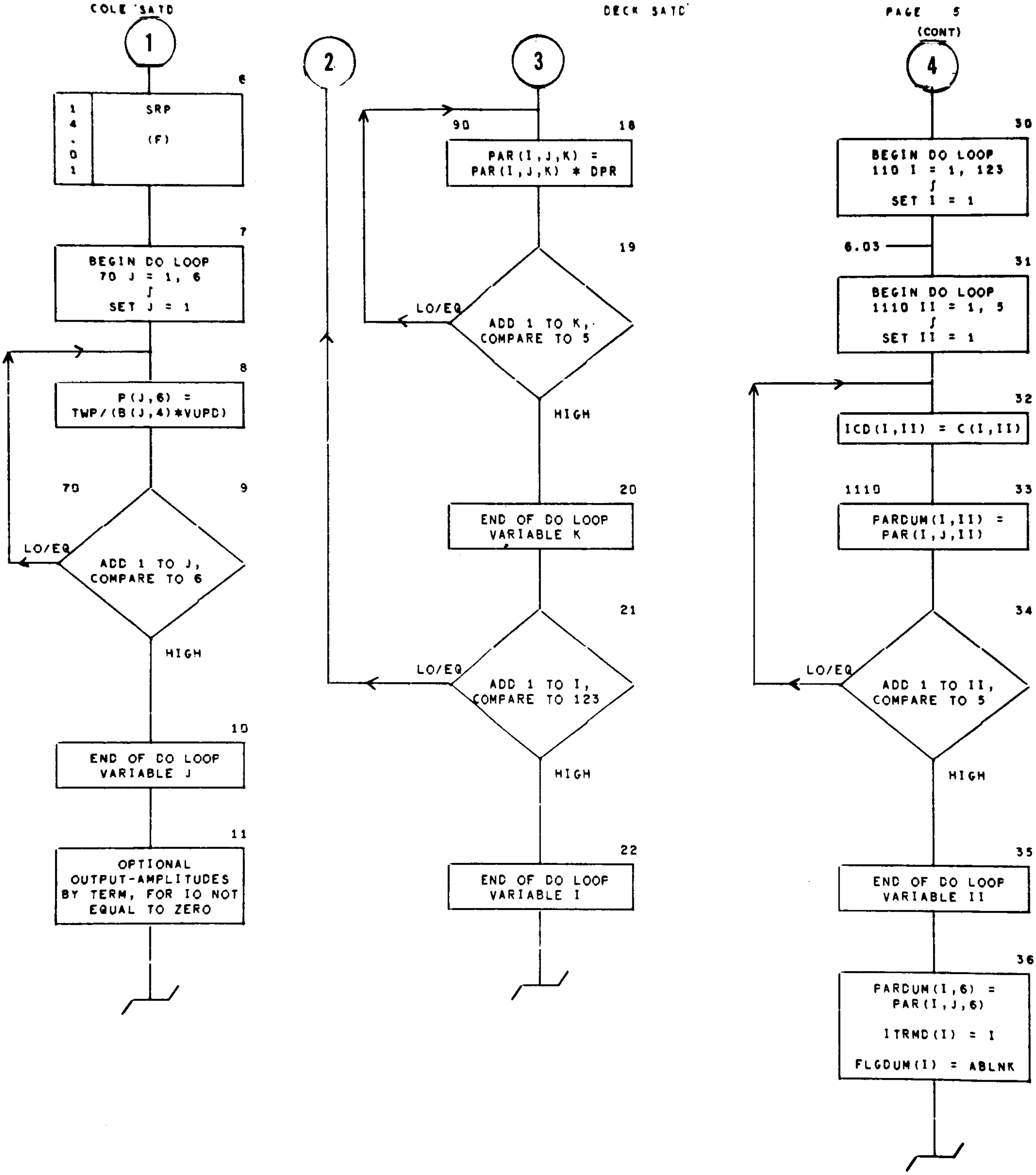

1
2
4
13.4472 IS CONVERSION FACTOR FROM CANONICAL UNIT OF TIME TO MINUTES
5
DAYS = DAYS + 1.
FMON = MONTH + 1
DELTO = DELTO - 3. * DELTP
DOI = OI * DPR
DCW = ECW * DPR
DW = EW * DPR
DEL = EEL * DPR
6
REWIND UNIT ITP
7
WRITE BINARY UNIT ITP
8
I/O LIST IS DELTP, FMON, DAYS, YEAR, SATID, A, E, DOI, DCW, DW, DEL, TEFM, PER, FKT, ONE
20
9
BEGIN DO LOOP 200 KK = 1, KT
SET KK = 1
3
21
15
ET - ETL
(0/+)
(-)
22
16
WRITE BCD UNIT M FORMAT 3920
17
I/O LIST IS KK
8.34
200
23
18
KSL(1) + KSL(2) + KF + ISEC(1) + ISEC(2)
(+)
(0/-)
24
19
WRITE BCD UNIT M FORMAT 3910
20
I/O LIST IS KK
8.34
200
25
21
T = TZ + ET/36525.
DELT = ET * VUFD - DOT
4.04
360

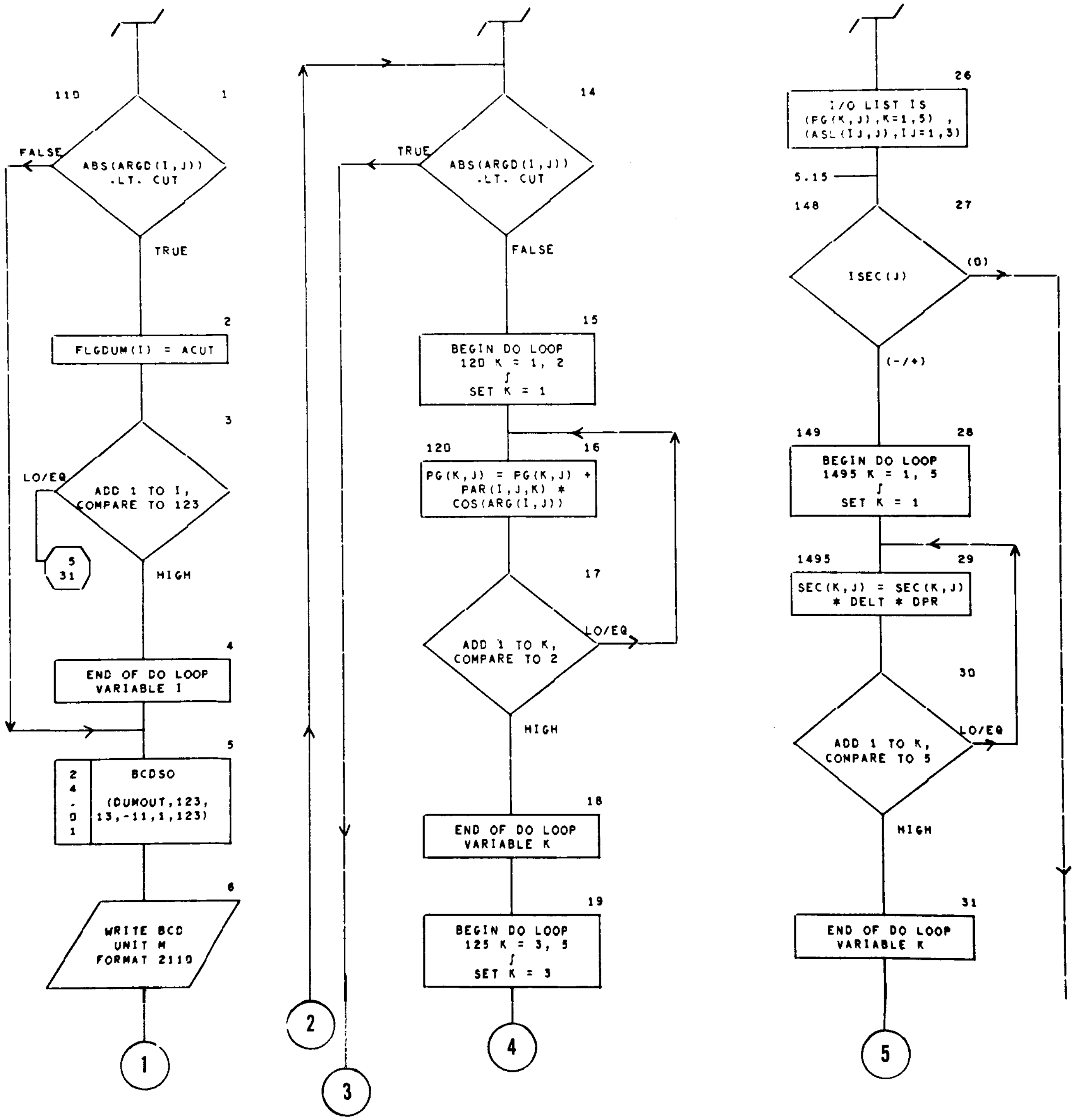

350
3.10
1
T = T + DELTI
ET = (T-TZ) * 36525.
DELT = DELTI * VUPD * 36525.
2
FALSE
KK .EQ. 1
TRUE
3
DELT = DELTO * VUPD
360
4
WRITE BCD UNIT M FORMAT 5011
5
I/O LIST IS SAT
6
WRITE BCD UNIT M FORMAT 2030
7
I/O LIST IS ET
1
14
FALSE
ISEC(2) + ISEC(1) .NE. 0
TRUE
15
WRITE BCD UNIT M FORMAT 2090
16
I/O LIST IS AS(IS1+1), AS(IS2+3)
17
FALSE
KR .NE. 0
TRUE
18
WRITE BCD UNIT M FORMAT 2040
19
I/O LIST IS F
2
3
4
26
WRITE BCD UNIT M FORMAT 3000
27
12.01
SUN (T)
28
13.01
MOON (T)
29
BEGIN DO LOOP 50 I = 1, 2 SET I = 1
5.03
30
TRUE
KSL(I) .EQ. 0
5 01
48
FALSE
31
16.01
SLGP (I)
32
5
6

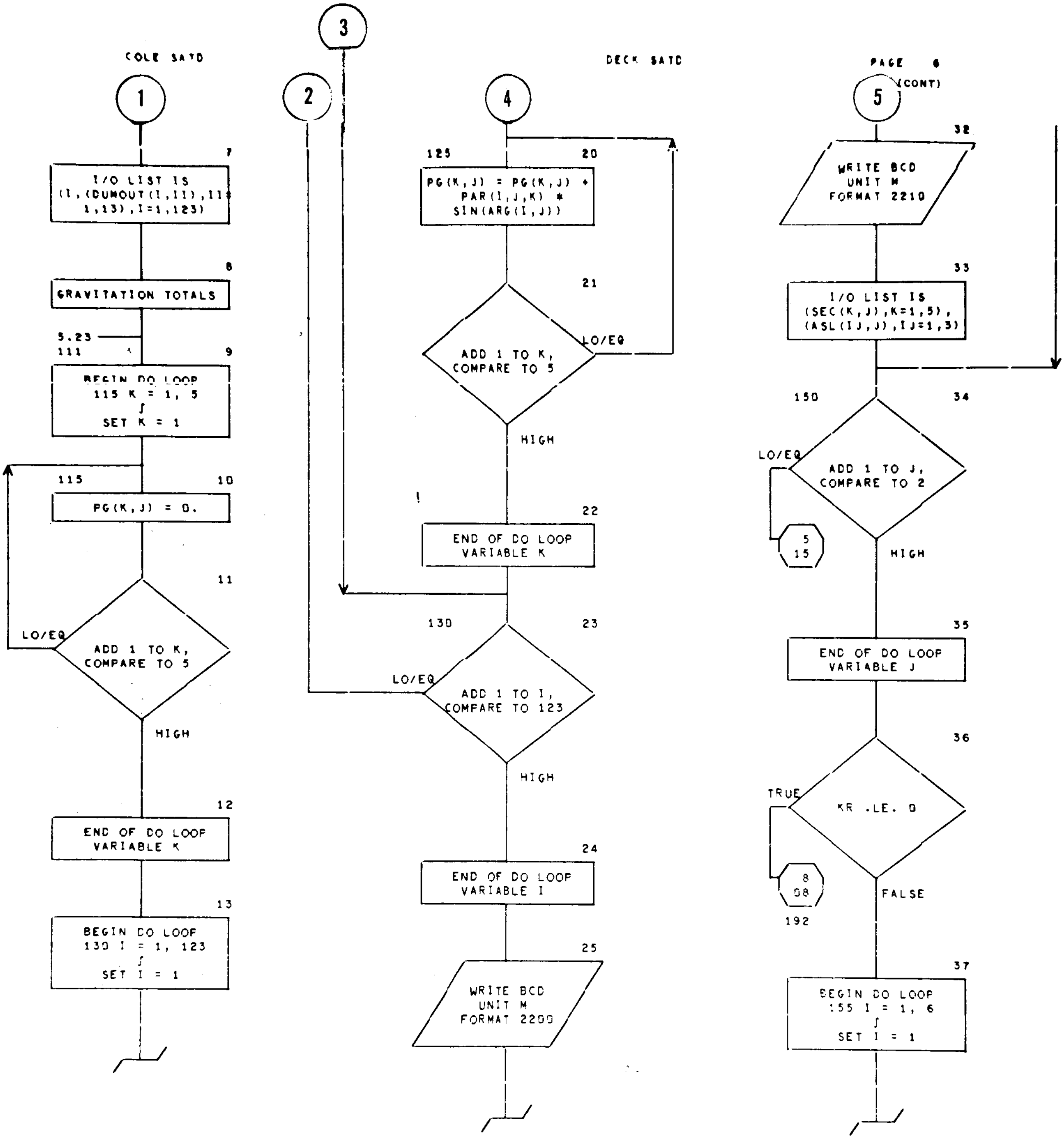


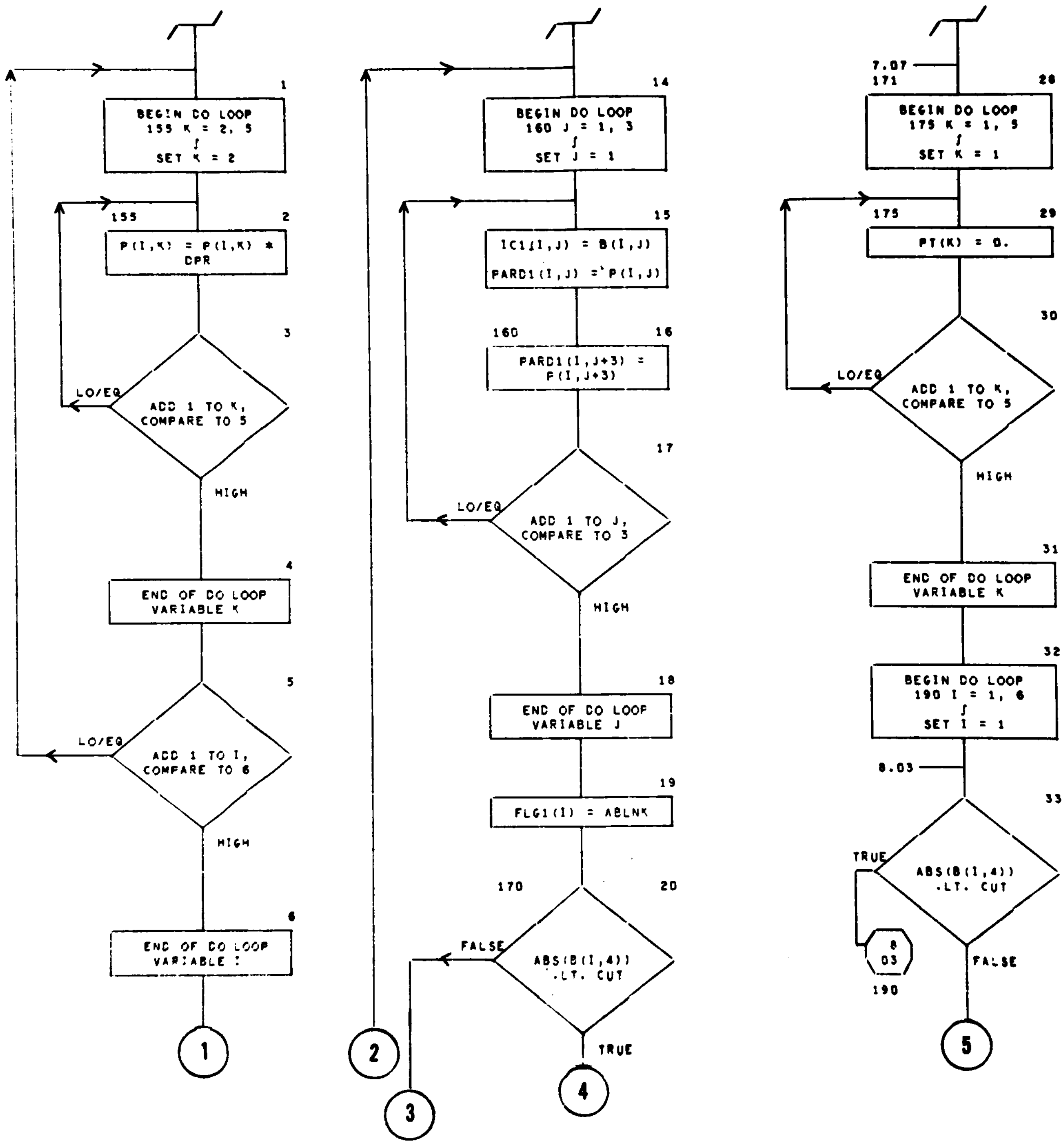
COLE SATD
DECK SATD
PAGE 4 (CONT)
1
2
3
4
5
6
8
KS .NE. 0
FALSE
TRUE
9
WRITE BCD UNIT M FORMAT 2020
10
I/O LIST IS (ASL(I,1),I = 1,3)
11
KL .NE. 0
FALSE
TRUE
12
WRITE BCD UNIT M FORMAT 2020
13
I/O LIST IS (ASL(I,2),I = 1,3)
20
1 0 . 0 1
SIX
21
E = EE
OI = EOI
EL = EL + DELT * ELD
EL = AMOD(EL,TWP)
W = W + DELT * WD
CW = CW + DELT * CWD
22
WRITE BCD UNIT M FORMAT 2050
23
I/O LIST IS A, E, OI, EL, W, CW, EN, T
24
CALL PERTURBATION SUBROUTINES
25
IBUG .NE. 0
FALSE
TRUE
BEGIN DO LOOP 40 J = 1, 123 SET J = 1
33
FAR(J,I,6) = TWF/(ARGD(J,I)*VUFD)
40
34
LO/EQ
ADD 1 TO J, COMPARE TO 123
HIGH
35
END OF DO LOOP VARIABLE J
5.03
50

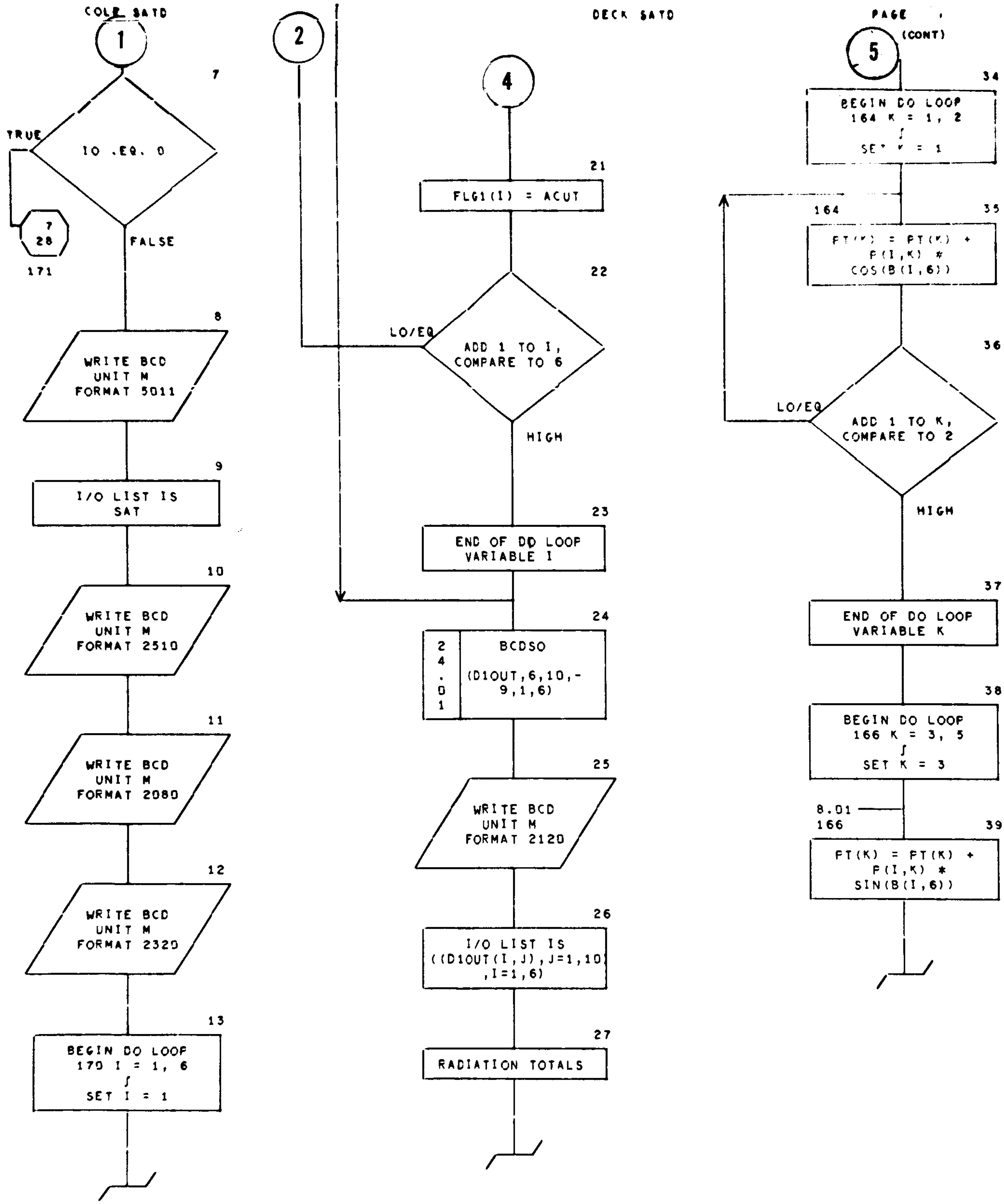

48
4.30
1
ISEC(I)
(0)
(-/+)
49
2
1 6 . 0 1
SLGP
(I)
50
3
LO/EQ
ADD 1 TO I, COMPARE TO 2
4
30
HIGH
4
END OF DO LOOP VARIABLE I
5
KR .EQ. 0
TRUE
FALSE
1
2
80
12
FALSE
IO .EQ. 0
TRUE
13
WRITE BCD UNIT M FORMAT 2100
14
BEGIN DO LOOP 150 J = 1, 2
SET J = 1
6.34
15
TRUE
KSL(J) .EQ. 0
6
27
148
FALSE
16
BEGIN DO LOOP 90 I = 1, 123
SET I = 1
17
BEGIN DO LOOP 90 K = 2, 5
SET K = 2
3
23
TRUE
IO .EQ. 0
6
09
111
FALSE
24
WRITE BCD UNIT M FORMAT 5011
25
I/O LIST IS SAT
26
WRITE BCD UNIT M FORMAT 2500
27
I/O LIST IS (ASL(K,J),K=1,3)
28
WRITE BCD UNIT M FORMAT 2080
29
WRITE BCD UNIT M FORMAT 2310
4


1
6
1
4
.
0
1
SRP
(F)
7
BEGIN DO LOOP
70 J = 1, 6
SET J = 1
8
P(J,6) =
TWP/(B(J,4)*VUPD)
70
9
ADD 1 TO J,
COMPARE TO 6
LO/EQ
HIGH
10
END OF DO LOOP
VARIABLE J
11
OPTIONAL
OUTPUT-AMPLITUDES
BY TERM, FOR IO NOT
EQUAL TO ZERO
2
3
90
18
PAR(I,J,K) =
PAR(I,J,K) * DPR
19
ADD 1 TO K,
COMPARE TO 5
LO/EQ
HIGH
20
END OF DO LOOP
VARIABLE K
21
ADD 1 TO I,
COMPARE TO 123
LO/EQ
HIGH
22
END OF DO LOOP
VARIABLE I
4
30
BEGIN DO LOOP
110 I = 1, 123
SET I = 1
6.03
31
BEGIN DO LOOP
1110 II = 1, 5
SET II = 1
32
ICD(I,II) = C(I,II)
1110
33
PARDUM(I,II) =
PAR(I,J,II)
34
ADD 1 TO II,
COMPARE TO 5
LO/EQ
HIGH
35
END OF DO LOOP
VARIABLE II
36
PARDUM(I,6) =
PAR(I,J,6)
ITRMD(I) = I
FLGDUM(I) = ABLNK

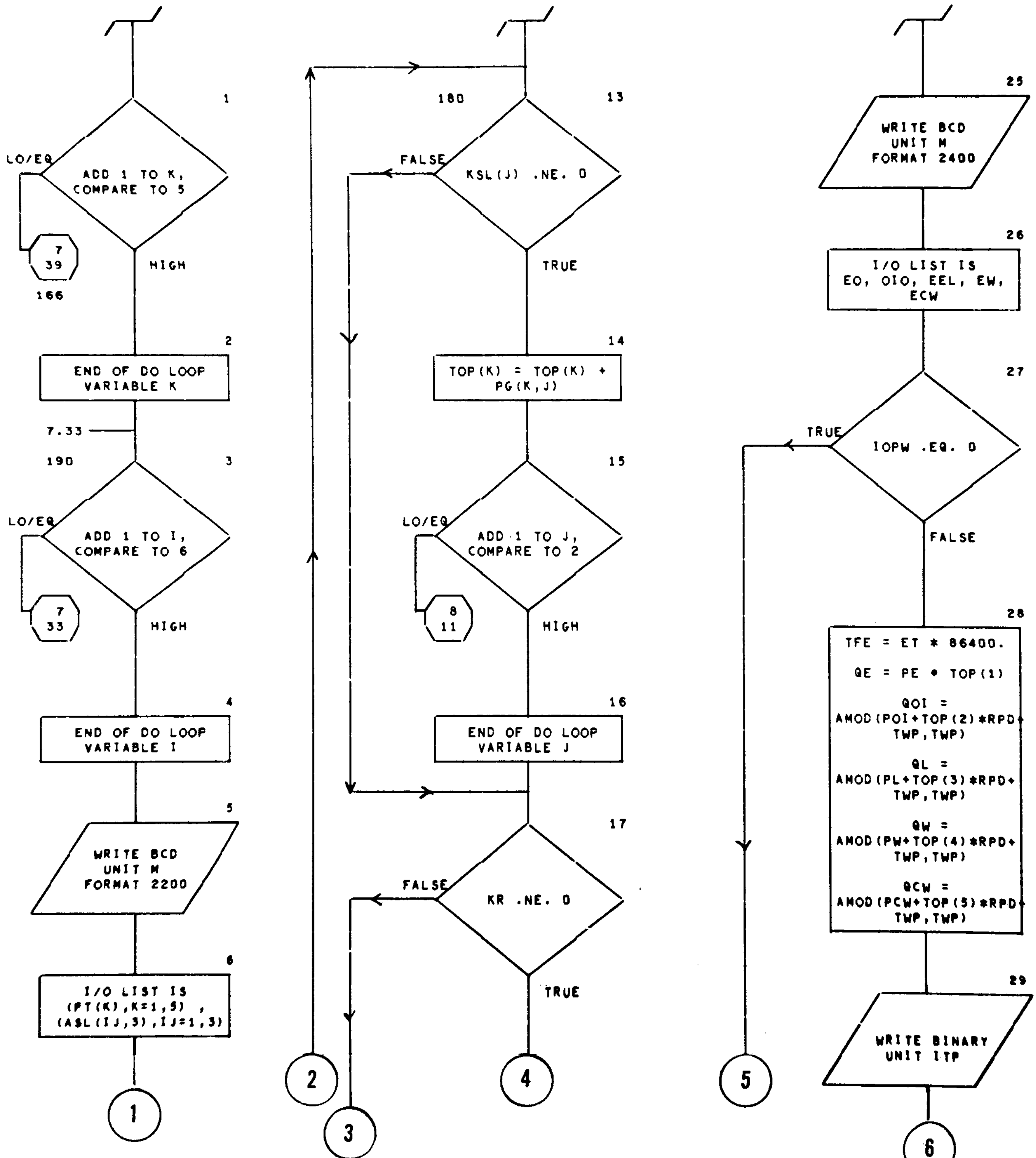

110
1
FALSE
ABS(ARGD(I,J)) .LT. CUT
TRUE
2
FLGDUM(I) = ACUT
3
LO/EQ
ADD 1 TO I, COMPARE TO 123
5
31
HIGH
4
END OF DO LOOP VARIABLE I
5
2 4 . 0 1
BCDSO
(DUMOUT,123, 13,-11,1,123)
6
WRITE BCD UNIT M FORMAT 2110
1
2
3
14
TRUE
ABS(ARGD(I,J)) .LT. CUT
FALSE
15
BEGIN DO LOOP 120 K = 1, 2
SET K = 1
120
16
PG(K,J) = PG(K,J) + PAR(I,J,K) * COS(ARG(I,J))
17
ADD 1 TO K, COMPARE TO 2
LO/EQ
HIGH
18
END OF DO LOOP VARIABLE K
19
BEGIN DO LOOP 125 K = 3, 5
SET K = 3
4
26
I/O LIST IS (PG(K,J),K=1,5) , (ASL(IJ,J),IJ=1,3)
5.15
148
27
ISEC(J)
(0)
(-/+)
149
28
BEGIN DO LOOP 1495 K = 1, 5
SET K = 1
1495
29
SEC(K,J) = SEC(K,J) * DELT * DPR
30
ADD 1 TO K, COMPARE TO 5
LO/EQ
HIGH
31
END OF DO LOOP VARIABLE K
5

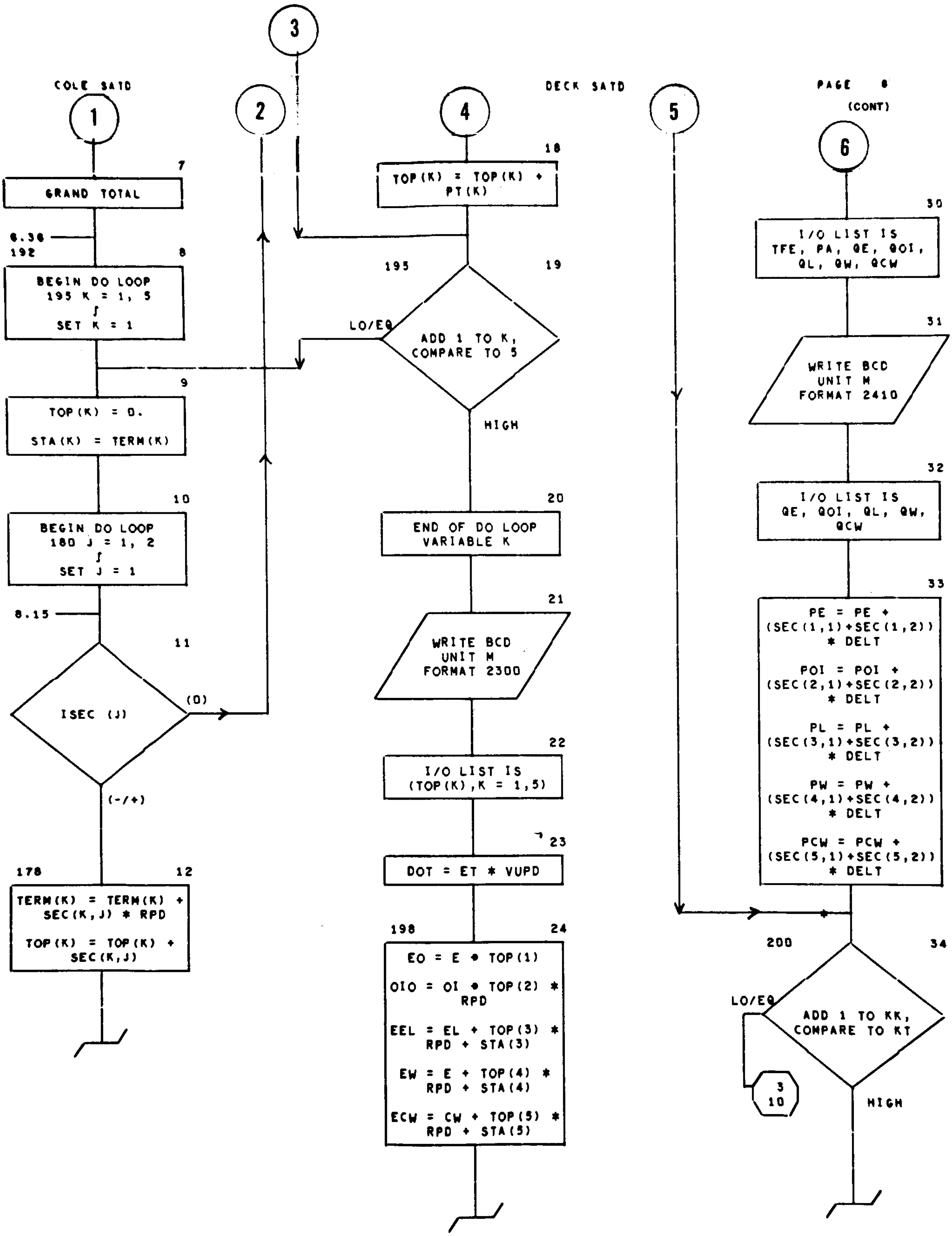

COLE SATD
DECK SATD
PAGE 6
(CONT)
1
2
3
4
5
7
I/O LIST IS
(I,(DUMOUT(I,II),II=1,13),I=1,123)
8
GRAVITATION TOTALS
5.23
111
9
BEGIN DO LOOP
115 K = 1, 5
SET K = 1
115
10
PG(K,J) = 0.
11
LO/EQ
ADD 1 TO K,
COMPARE TO 5
HIGH
12
END OF DO LOOP
VARIABLE K
13
BEGIN DO LOOP
130 I = 1, 123
SET I = 1
125
20
PG(K,J) = PG(K,J) +
PAR(I,J,K) *
SIN(ARG(I,J))
21
LO/EQ
ADD 1 TO K,
COMPARE TO 5
HIGH
22
END OF DO LOOP
VARIABLE K
130
23
LO/EQ
ADD 1 TO I,
COMPARE TO 123
HIGH
24
END OF DO LOOP
VARIABLE I
25
WRITE BCD
UNIT M
FORMAT 2200
32
WRITE BCD
UNIT M
FORMAT 2210
33
I/O LIST IS
(SEC(K,J),K=1,5),
(ASL(IJ,J),IJ=1,3)
150
34
LO/EQ
ADD 1 TO J,
COMPARE TO 2
5
15
HIGH
35
END OF DO LOOP
VARIABLE J
36
TRUE
KR .LE. 0
8
98
192
FALSE
37
BEGIN DO LOOP
155 I = 1, 6
SET I = 1

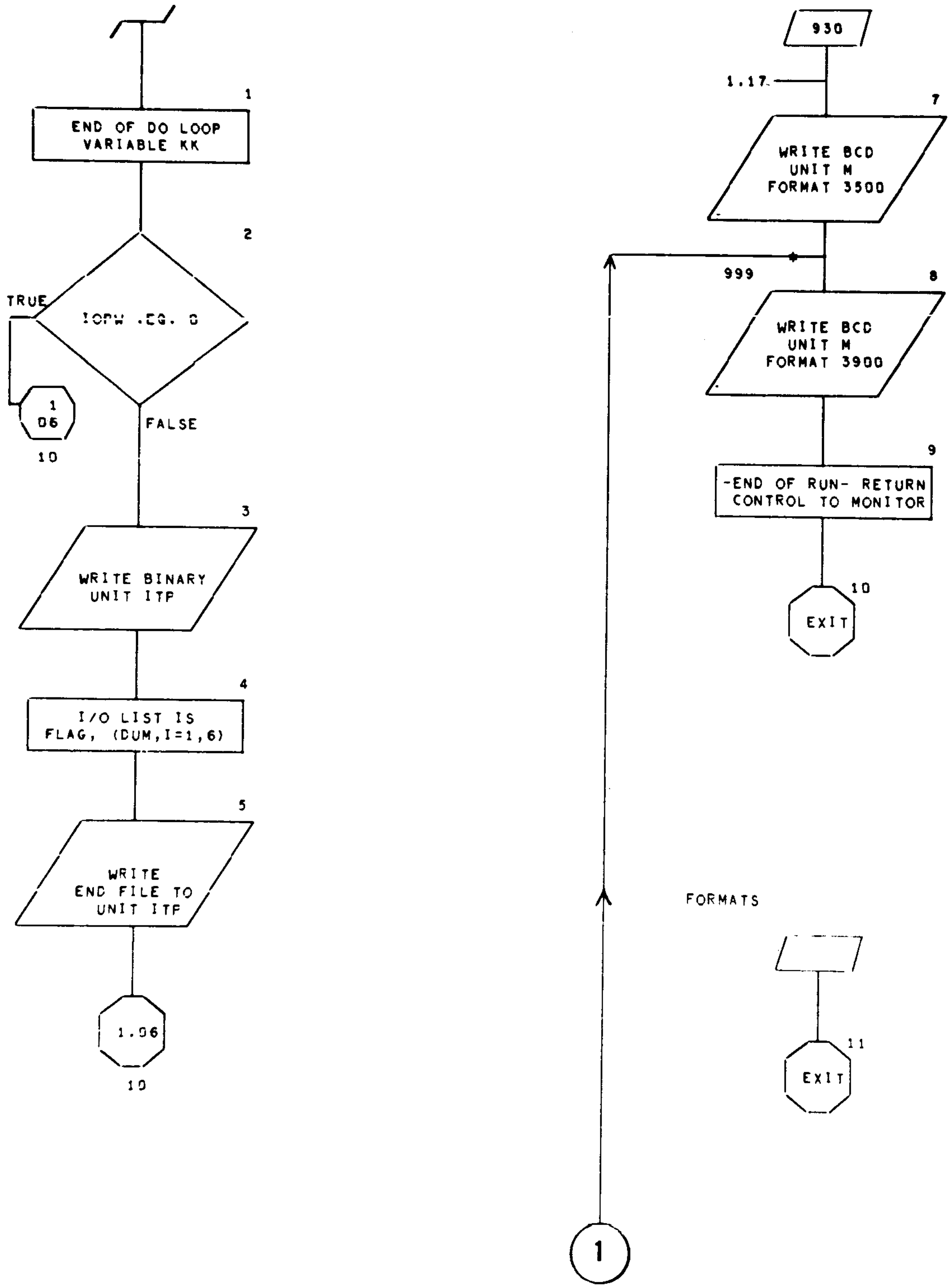

1
BEGIN DO LOOP
155 K = 2, 5
SET K = 2
155
2
P(I,K) = P(I,K) *
DPR
3
LO/EQ
ADD 1 TO K,
COMPARE TO 5
HIGH
4
END OF DO LOOP
VARIABLE K
5
LO/EQ
ADD 1 TO I,
COMPARE TO 6
HIGH
6
END OF DO LOOP
VARIABLE I
1
14
BEGIN DO LOOP
160 J = 1, 3
SET J = 1
15
IC1(I,J) = B(I,J)
PARD1(I,J) = P(I,J)
160
16
PARD1(I,J+3) =
P(I,J+3)
17
LO/EQ
ADD 1 TO J,
COMPARE TO 3
HIGH
18
END OF DO LOOP
VARIABLE J
19
FLG1(I) = ABLNK
170
20
FALSE
ABS(B(I,4))
.LT. CUT
TRUE
2
3
4
7.07
171
28
BEGIN DO LOOP
175 K = 1, 5
SET K = 1
175
29
PT(K) = 0.
30
LO/EQ
ADD 1 TO K,
COMPARE TO 5
HIGH
31
END OF DO LOOP
VARIABLE K
32
BEGIN DO LOOP
190 I = 1, 6
SET I = 1
8.03
33
TRUE
ABS(B(I,4))
.LT. CUT
8
03
190
FALSE
5

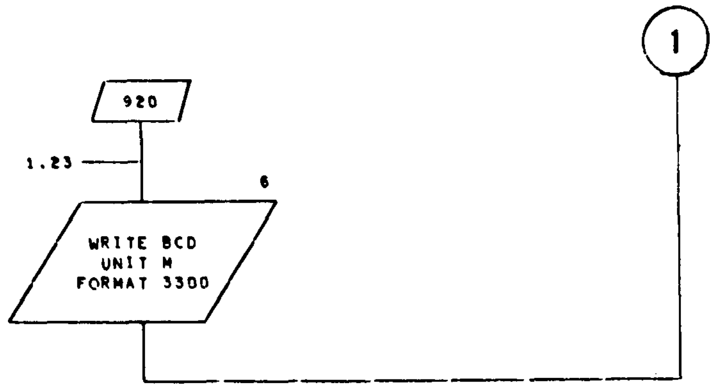


COLR SATD
DECK SATD
PAGE
(CONT)
1
7
TRUE
IO .EQ. 0
FALSE
7
28
171
8
WRITE BCD UNIT M FORMAT 5011
9
I/O LIST IS SAT
10
WRITE BCD UNIT M FORMAT 2510
11
WRITE BCD UNIT M FORMAT 2080
12
WRITE BCD UNIT M FORMAT 2320
13
BEGIN DO LOOP 170 I = 1, 6 SET I = 1
2
4
21
FLG1(I) = ACUT
22
LO/EQ
ADD 1 TO I, COMPARE TO 6
HIGH
23
END OF DO LOOP VARIABLE I
24
24.01
BCDSO (D1OUT,6,10,-9,1,6)
25
WRITE BCD UNIT M FORMAT 2120
26
I/O LIST IS ((D1OUT(I,J),J=1,10),I=1,6)
27
RADIATION TOTALS
5
34
BEGIN DO LOOP 164 K = 1, 2
164
35
FT(K) = FT(K) + F(I,K) * COS(B(I,6))
36
LO/EQ
ADD 1 TO K, COMPARE TO 2
HIGH
37
END OF DO LOOP VARIABLE K
38
BEGIN DO LOOP 166 K = 3, 5 SET K = 3
8.01
166
39
FT(K) = FT(K) + F(I,K) * SIN(B(I,6))


1
ADD 1 TO K, COMPARE TO 5
LO/EQ
7
39
166
HIGH
2
END OF DO LOOP VARIABLE K
7.33
190
3
ADD 1 TO I, COMPARE TO 6
LO/EQ
7
33
HIGH
4
END OF DO LOOP VARIABLE I
5
WRITE BCD UNIT M FORMAT 2200
6
I/O LIST IS (PT(K),K=1,5) , (ASL(IJ,3),IJ=1,3)
1
180
13
KSL(J) .NE. 0
FALSE
TRUE
14
TOP(K) = TOP(K) + PG(K,J)
15
ADD 1 TO J, COMPARE TO 2
LO/EQ
8
11
HIGH
16
END OF DO LOOP VARIABLE J
17
KR .NE. 0
FALSE
TRUE
2
3
4
25
WRITE BCD UNIT M FORMAT 2400
26
I/O LIST IS EO, OIO, EEL, EW, ECW
27
IOPW .EQ. 0
TRUE
FALSE
28
TFE = ET * 86400.
QE = PE * TOP(1)
QOI = AMOD(POI+TOP(2)*RPD+TWP,TWP)
QL = AMOD(PL+TOP(3)*RPD+TWP,TWP)
QW = AMOD(PW+TOP(4)*RPD+TWP,TWP)
QCW = AMOD(PCW+TOP(5)*RPD+TWP,TWP)
29
WRITE BINARY UNIT ITP
5
6


COLE SATD
DECK SATD
PAGE 8
(CONT)
1
2
3
4
5
6
7
GRAND TOTAL
8.36
192
8
BEGIN DO LOOP
195 K = 1, 5
SET K = 1
9
TOP(K) = 0.
STA(K) = TERM(K)
10
BEGIN DO LOOP
180 J = 1, 2
SET J = 1
8.15
11
ISEC (J)
(0)
(-/+)
178
12
TERM(K) = TERM(K) + SEC(K,J) * RPD
TOP(K) = TOP(K) + SEC(K,J)
18
TOP(K) = TOP(K) + PT(K)
195
19
LO/EQ
ADD 1 TO K, COMPARE TO 5
HIGH
20
END OF DO LOOP VARIABLE K
21
WRITE BCD UNIT M FORMAT 2300
22
I/O LIST IS (TOP(K),K = 1,5)
23
DOT = ET * VUPD
198
24
EO = E + TOP(1)
OIO = OI + TOP(2) * RPD
EEL = EL + TOP(3) * RPD + STA(3)
EW = E + TOP(4) * RPD + STA(4)
ECW = CW + TOP(5) * RPD + STA(5)
30
I/O LIST IS TFE, PA, QE, QOI, QL, QW, QCW
31
WRITE BCD UNIT M FORMAT 2410
32
I/O LIST IS QE, QOI, QL, QW, QCW
33
PE = PE + (SEC(1,1)+SEC(1,2)) * DELT
POI = POI + (SEC(2,1)+SEC(2,2)) * DELT
PL = PL + (SEC(3,1)+SEC(3,2)) * DELT
PW = PW + (SEC(4,1)+SEC(4,2)) * DELT
PCW = PCW + (SEC(5,1)+SEC(5,2)) * DELT
200
34
LO/EQ
ADD 1 TO KK, COMPARE TO KT
3
10
HIGH


1
END OF DO LOOP
VARIABLE KK
2
TRUE
IOPW .EQ. 0
1
06
10
FALSE
3
WRITE BINARY
UNIT ITP
4
I/O LIST IS
FLAG, (DUM,I=1,6)
5
WRITE
END FILE TO
UNIT ITP
1.06
10
930
1.17
7
WRITE BCD
UNIT M
FORMAT 3500
999
8
WRITE BCD
UNIT M
FORMAT 3900
9
-END OF RUN- RETURN
CONTROL TO MONITOR
10
EXIT
FORMATS
11
EXIT
1


1
920
1.23
6
WRITE BCD
UNIT M
FORMAT 3300

IV. SUBROUTINE SIX

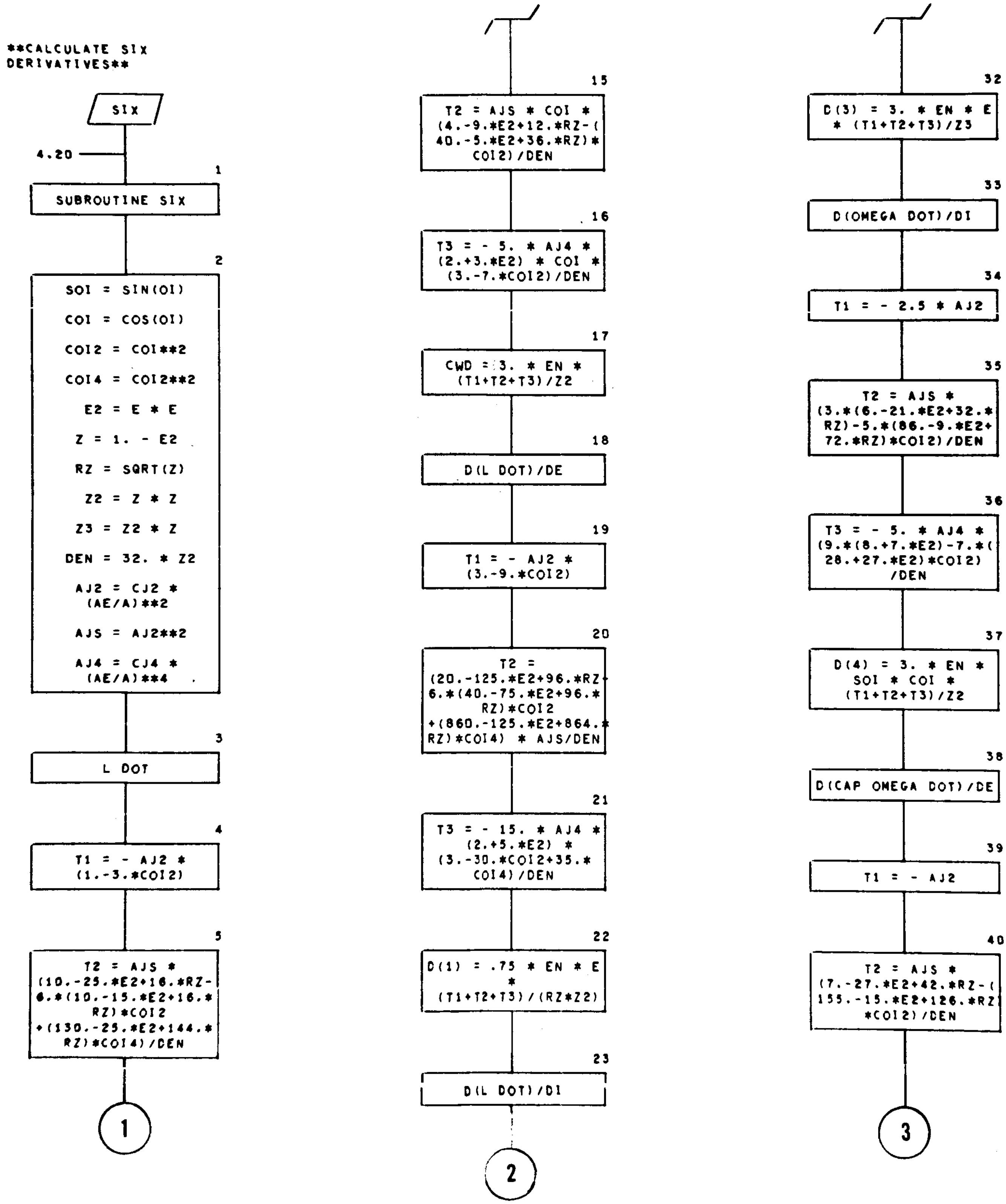
This subroutine computes the set of six derivatives:

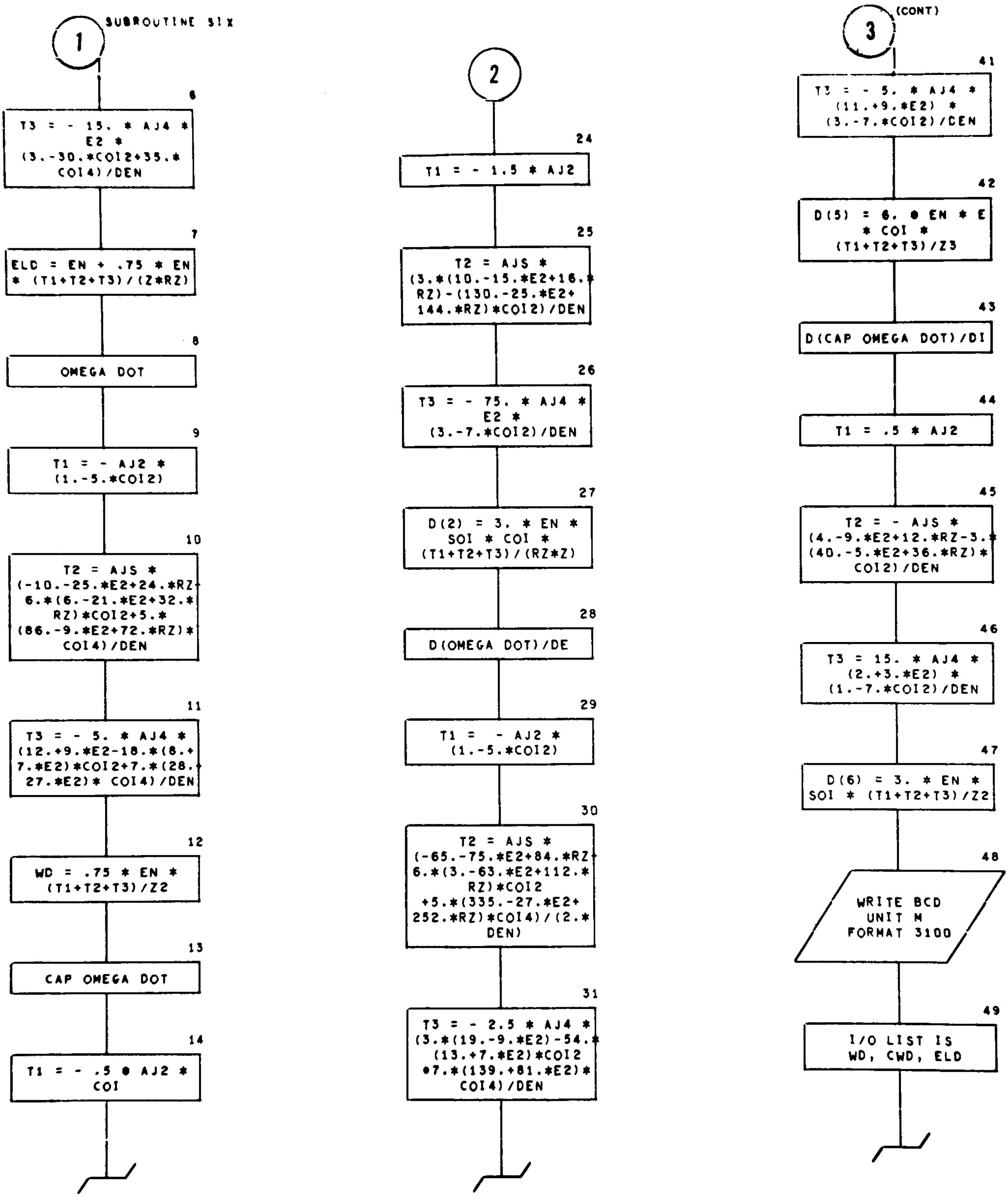
$$\frac{d\dot{l}}{de}, \quad \frac{d\dot{l}}{di}, \quad \frac{d\dot{\omega}}{de}, \quad \frac{d\dot{\omega}}{di}, \quad \frac{d\dot{\Omega}}{de}, \quad \frac{d\dot{\Omega}}{di}$$

from pages 8, 9 and 43 of Reference 2. (See page 22 of Reference 1.)

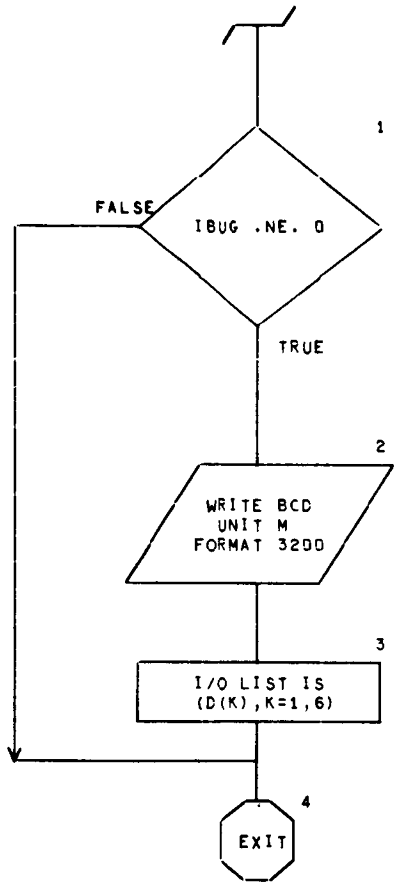
```
DECK SIXD
      COMMON/ORB/Q(28),A,E,OI,EL,W,CW,EN,IBUG,L,M
      COMMON/DER/D(6),WD,CWD,ELD
      COMMON/CONS/ CJ2,CJ4,AE,PLIM
 3100 FORMAT(1H010X9HOMEGA DOT,E16.8,5X13HCAP OMEGA DOT,E16.8,5X5HL DOT,
      E16.8 ,3X,12H(OBLATENESS)  )
 3200 FORMAT(1H03X11HD(L DOT)/DE,5X11HD(L DOT)/DI,3X15HD(OMEGA DOT)/DE,
      1X15HD(OMEGA DOT)/DI,2X19HD(CAP OMEGA DOT)/DE,2X19HD(CAP OMEGA DOT
      )/DI/4E16.8,2E20.8)
```

SUBROUTINE SIX




SUBROUTINE SIX
1
6
T3 = - 15. * AJ4 * E2 * (3.-30.*COI2+35.* COI4)/DEN
7
ELD = EN + .75 * EN * (T1+T2+T3)/(Z*RZ)
8
OMEGA DOT
9
T1 = - AJ2 * (1.-5.*COI2)
10
T2 = AJS * (-10.-25.*E2+24.*RZ+ 6.*(6.-21.*E2+32.* RZ)*COI2+5.* (86.-9.*E2+72.*RZ)* COI4)/DEN
11
T3 = - 5. * AJ4 * (12.+9.*E2-18.*(8.+ 7.*E2)*COI2+7.*(28.+ 27.*E2)* COI4)/DEN
12
WD = .75 * EN * (T1+T2+T3)/Z2
13
CAP OMEGA DOT
14
T1 = - .5 * AJ2 * COI
2
24
T1 = - 1.5 * AJ2
25
T2 = AJS * (3.*(10.-15.*E2+16.* RZ)-(130.-25.*E2+ 144.*RZ)*COI2)/DEN
26
T3 = - 75. * AJ4 * E2 * (3.-7.*COI2)/DEN
27
D(2) = 3. * EN * SOI * COI * (T1+T2+T3)/(RZ*Z)
28
D(OMEGA DOT)/DE
29
T1 = - AJ2 * (1.-5.*COI2)
30
T2 = AJS * (-65.-75.*E2+84.*RZ+ 6.*(3.-63.*E2+112.* RZ)*COI2 +5.*(335.-27.*E2+ 252.*RZ)*COI4)/(2.* DEN)
31
T3 = - 2.5 * AJ4 * (3.*(19.-9.*E2)-54.* (13.+7.*E2)*COI2 +7.*(139.+81.*E2)* COI4)/DEN
3
(CONT)
41
T3 = - 5. * AJ4 * (11.+9.*E2) * (3.-7.*COI2)/DEN
42
D(5) = 6. * EN * E * COI * (T1+T2+T3)/Z3
43
D(CAP OMEGA DOT)/DI
44
T1 = .5 * AJ2
45
T2 = - AJS * (4.-9.*E2+12.*RZ-3.* (40.-5.*E2+36.*RZ)* COI2)/DEN
46
T3 = 15. * AJ4 * (2.+3.*E2) * (1.-7.*COI2)/DEN
47
D(6) = 3. * EN * SOI * (T1+T2+T3)/Z2
48
WRITE BCD UNIT M FORMAT 3100
49
I/O LIST IS WD, CWD, ELD

SUBROUTINE SIX



V. SUBROUTINE SUN

Subroutine SUN computes solar ephemeris quantities and their derivatives with respect to time using the relationships on page 46 of Reference 2. These quantities are referenced to the earth's equatorial plane. (See page 22 of Reference 1.)

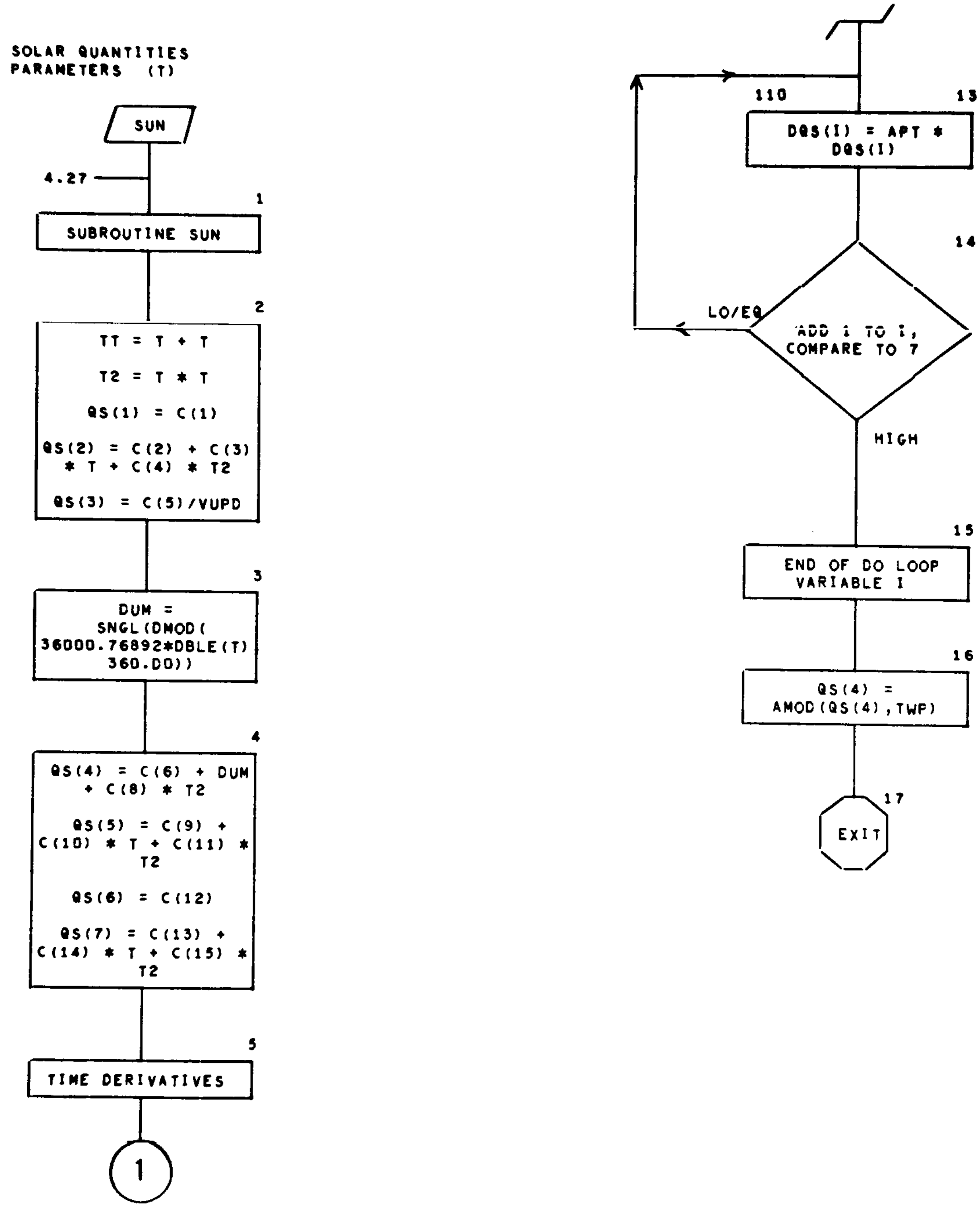
```
DECK SUND

          COMMON/ORB/QS(7),DQS(7),QL(7),DQL(7),A,E,OI,EL,W,CW,EN

          DIMENSION C(15)

          DATA (C(I),I = 1,15)/0.999997,0.01675104,-0.418E-4,-0.13E-6,
          0.98560027,279.69668,36000.7689 ,0.3E-3,281.22083,
          1.719175,0.4528E-3,0.,23.452294,-0.0130125,-0.164E-5/,
          RPD/.0174532925/,TWP/6.2831853/,APT/.44622973E-8/,VUPD/107.085/
```

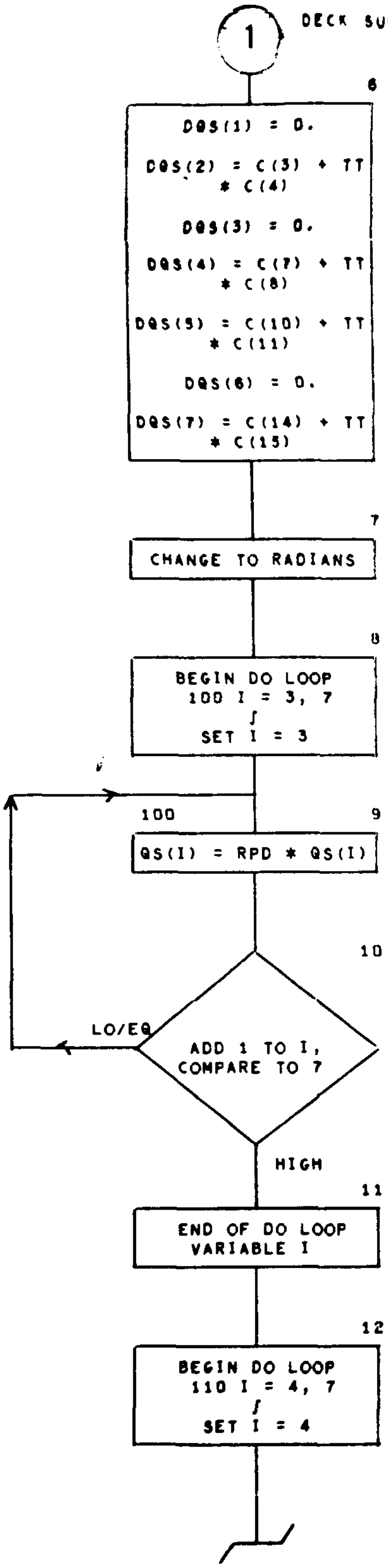
DECK SUND

SUBROUTINE SUN

12.01	SUN	4.27*
12.09	100	12.10
12.13	110	12.14

SUBROUTINE SUN




1
6
DQS(1) = 0.
DQS(2) = C(3) + TT * C(4)
DQS(3) = 0.
DQS(4) = C(7) + TT * C(8)
DQS(5) = C(10) + TT * C(11)
DQS(6) = 0.
DQS(7) = C(14) + TT * C(15)
7
CHANGE TO RADIANS
8
BEGIN DO LOOP 100 I = 3, 7 SET I = 3
100
9
QS(I) = RPD * QS(I)
10
ADD 1 TO I, COMPARE TO 7
LO/EQ
HIGH
11
END OF DO LOOP VARIABLE I
12
BEGIN DO LOOP 110 I = 4, 7 SET I = 4

VI. SUBROUTINE MOON

The relationships on page 47 and 48 of Reference 2 are used to compute lunar ephemeris quantities and their time derivatives (referred to the Earth's equatorial plane). (See page 23 of Reference 1.)

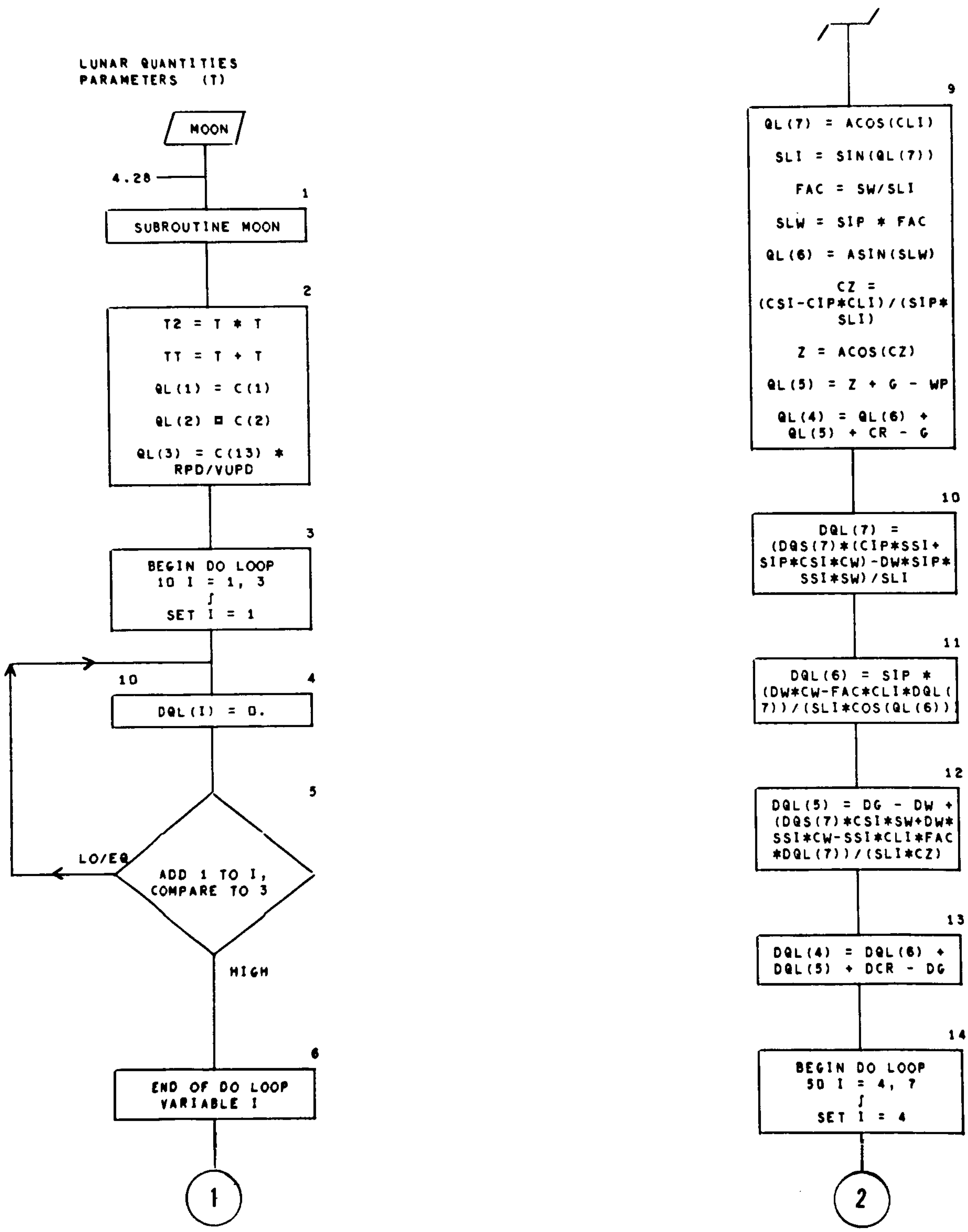
```
DECK MOOND

      COMMON/ORB/QS(7),DQS(7),QL(7),DQL(7),A,E,OI,EL,W,ZW,EN,IBUG,L,M

      DIMENSION C(14)

      DATA(C(I),I = 1,14)/.012150668,.054900489,270.43416,481267.883
     -0.00113,334.32956,4069.03403,-0.010325,-.12E-4,259.183275,
     -1934.14201,.00208,13.064993,5.1453964/,
     RPD/.0174532925/,TWP/6.2831853/,APT/.44622973E-8/,VUPD/107.085/

 3300 FORMAT(1H021X5HSOLAR17X3HDOT15X5HLUNAR17X3HDOT/
     9X1HM4E20.8/9X1HE4E20.8/9X1HN4E20.8/4X6HLAMBDA4E20.8/
     5X5HOMEGA4E20.8/1X9HCAP OMEGA4E20.8/9X1HI4E20.8)
```

DECK MOOND

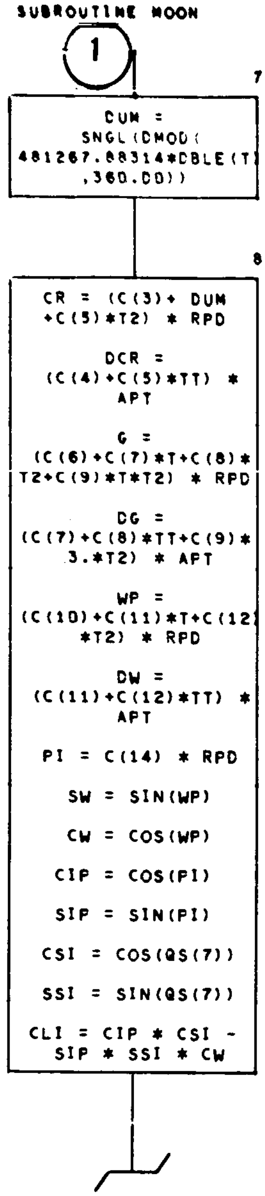
SUBROUTINE MOON

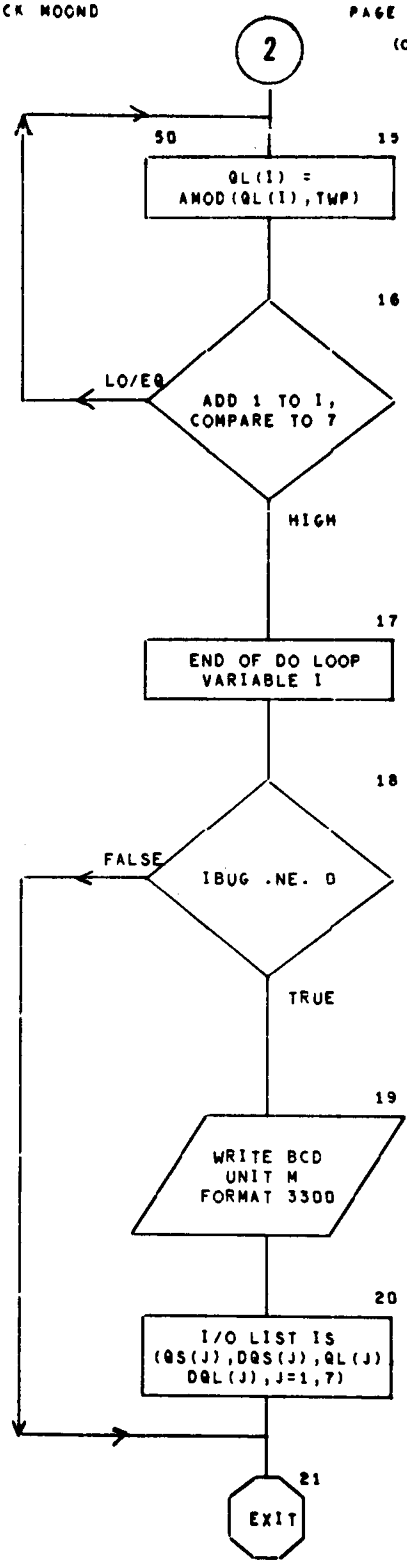
13.01	MOON	4.28*
13.04	10	13.05
13.15	50	13.16
13.21		13.18

SUBROUTINE MOON



SUBROUTINE MOON





VII. SUBROUTINE SRP

The amplitude and phase of each term in the equations from pages 44, 45 and 46 of Reference 2 for Solar Radiation Pressure is computed by this subroutine. (See page 21 of Reference 1.)

DECK SRPD

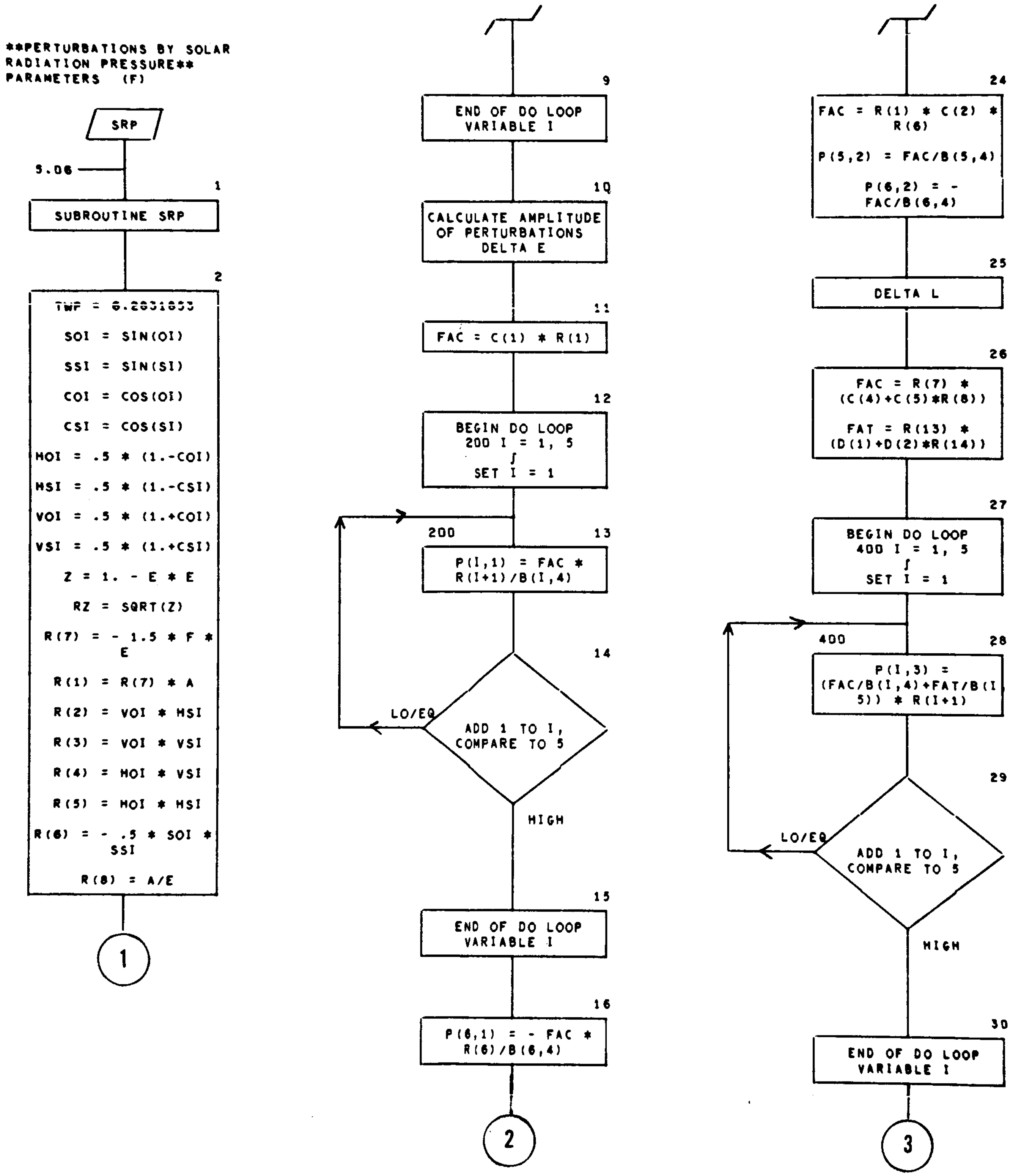
```
      DIMENSION R(15),C(5)
      COMMON/ORB/QS(7),DQS(7),QL(7),DQL(7),A,E,OI,EL,W,CW,EN,IBUG,L,M
      COMMON/DER/D(6),WD,CWD
      COMMON/RAD/P(6,6),B(6,6)
      EQUIVALENCE(SI,QS(7)),(SLD,DQS(4)),(SL,QS(4))
```

DECK SRPD

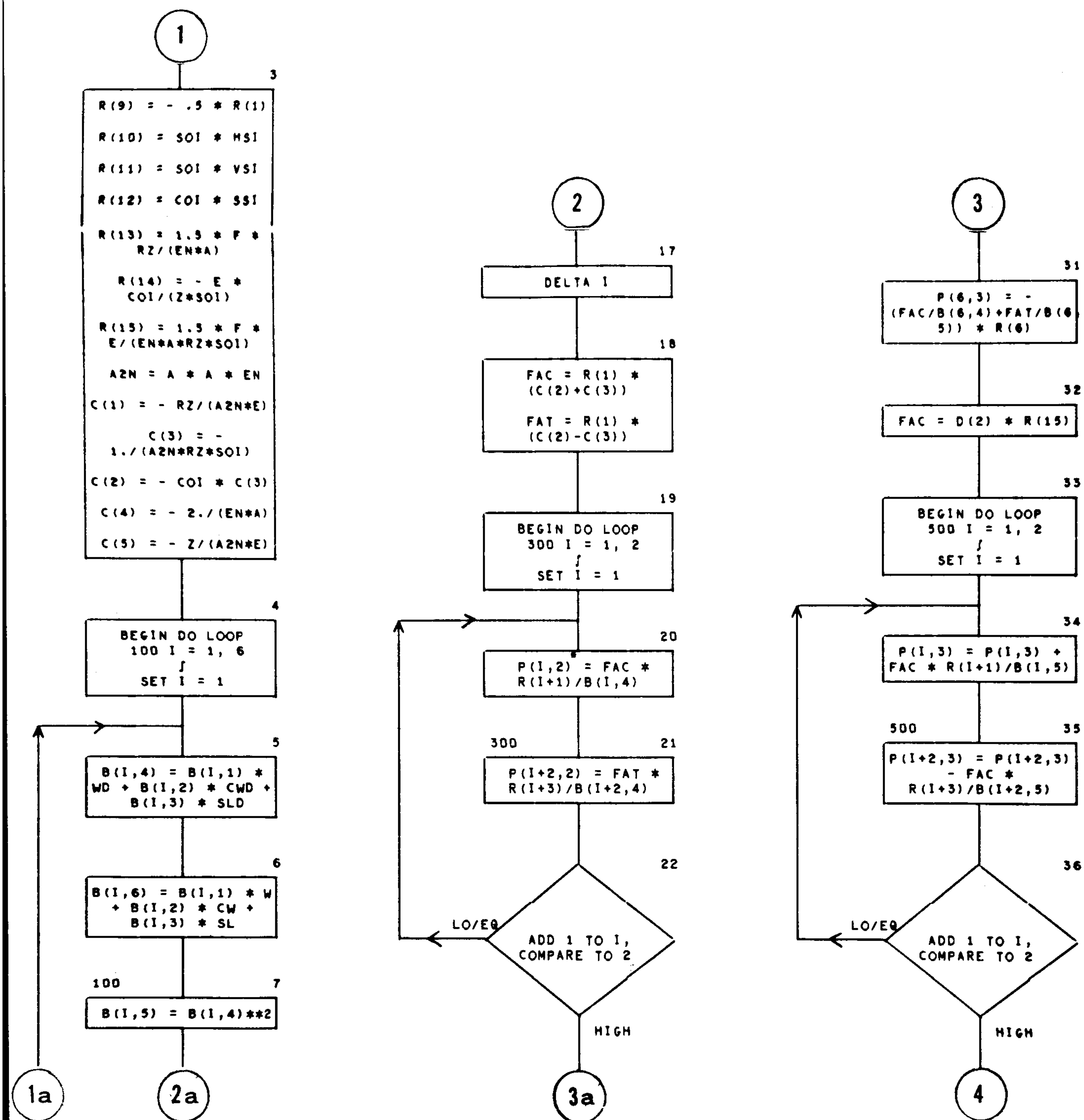
SUBROUTINE SRP

14.01	SRP	5.06*
14.05		14.08
14.07	100	
14.13	200	14.14
14.20		14.22
14.21	300	
14.28	400	14.29
14.34		14.36
14.35	500	
15.03	600	15.04
15.09		15.13
15.12	700	
15.18	800	15.19
15.23		15.27
15.26	900	

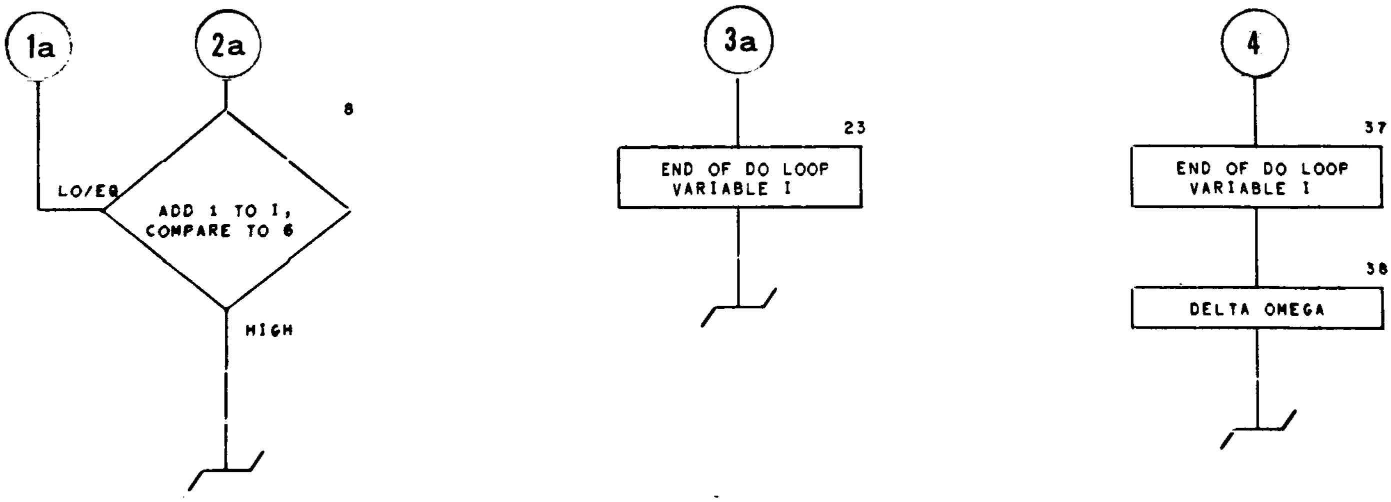
SUBROUTINE SRP



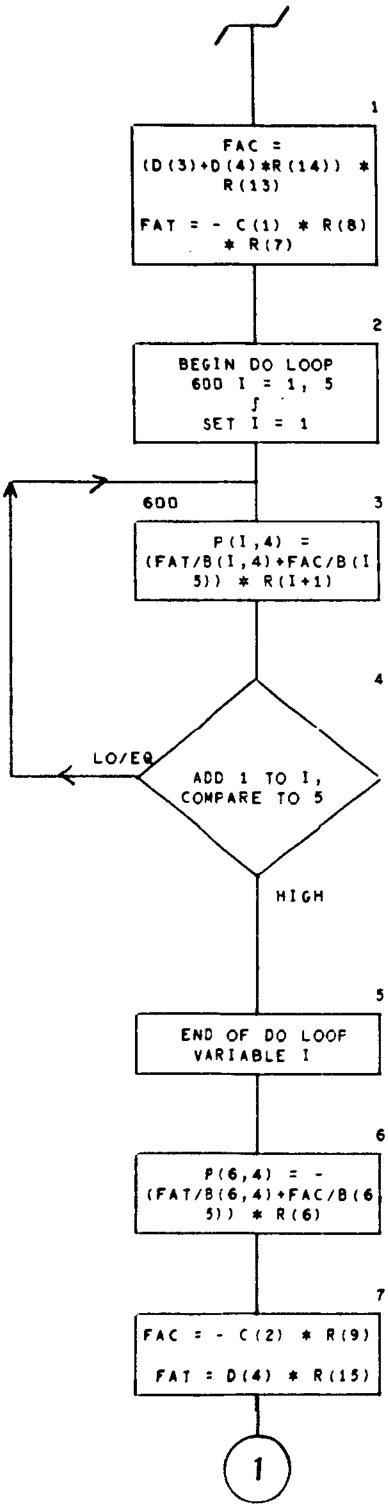
SUBROUTINE SRP

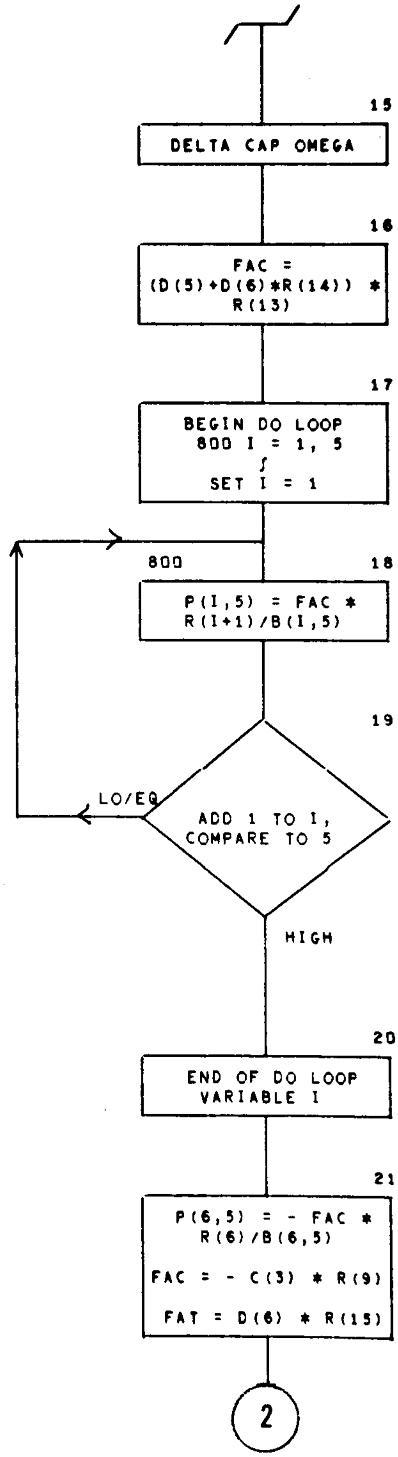


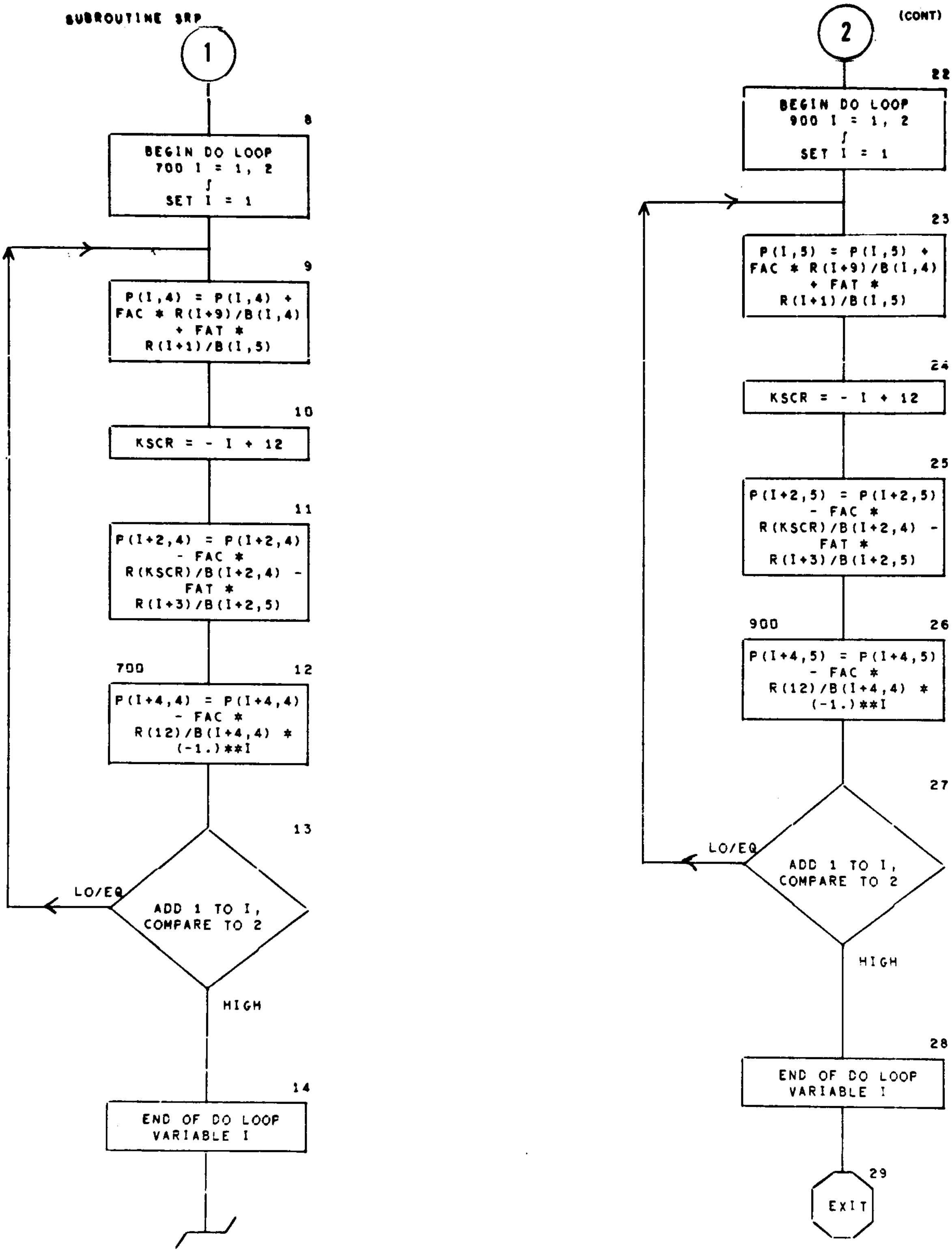
SUBROUTINE SRP



SUBROUTINE SRP






SUBROUTINE SRP
1
8
BEGIN DO LOOP
700 I = 1, 2
SET I = 1
9
P(I,4) = P(I,4) + FAC * R(I+9)/B(I,4) + FAT * R(I+1)/B(I,5)
10
KSCR = - I + 12
11
P(I+2,4) = P(I+2,4) - FAC * R(KSCR)/B(I+2,4) - FAT * R(I+3)/B(I+2,5)
700
12
P(I+4,4) = P(I+4,4) - FAC * R(12)/B(I+4,4) * (-1.)**I
13
LO/EQ
ADD 1 TO I, COMPARE TO 2
HIGH
14
END OF DO LOOP VARIABLE I
2
(CONT)
22
BEGIN DO LOOP
900 I = 1, 2
SET I = 1
23
P(I,5) = P(I,5) + FAC * R(I+9)/B(I,4) + FAT * R(I+1)/B(I,5)
24
KSCR = - I + 12
25
P(I+2,5) = P(I+2,5) - FAC * R(KSCR)/B(I+2,4) - FAT * R(I+3)/B(I+2,5)
900
26
P(I+4,5) = P(I+4,5) - FAC * R(12)/B(I+4,4) * (-1.)**I
27
LO/EQ
ADD 1 TO I, COMPARE TO 2
HIGH
28
END OF DO LOOP VARIABLE I
29
EXIT

VIII. SUBROUTINE SLGP

The Solar and Lunar Gravitational Perturbations subroutine, SLGP, computes both long-period and secular effects using equations 4 and 5 from page 9 of Reference 2. The amplitude of each of the long period terms is also computed (See page 20 of Reference 1).

DECK SLGPD

```
      DIMENSION Z(67),AC(23,7)
      DIMENSION XAP(2),COEFA(8,2)
      COMMON /ORB/ Q(14,2),XA,XE,XI,EL,OMA,COM,XN
      COMMON /PERT/ ARG(125,2),ARGDOT(125,2),DE(125,2),DI(125,2),DL(125,
     2),DW(125,2),DOM(125,2),PER(125,2),SEC(5,2)
      COMMON /COEF/ CLAMP(125),COMAP(125),CCOMP(125),COMA(125),CCOM(125)
      COMMON /DER/ D(6),OMADT,COMDT,ELD,ISEC(2),KSL(2)
      REAL LAMP,LAMPDT
      DATA XAP(1),XAP(2)/23440.,60.2681/
```

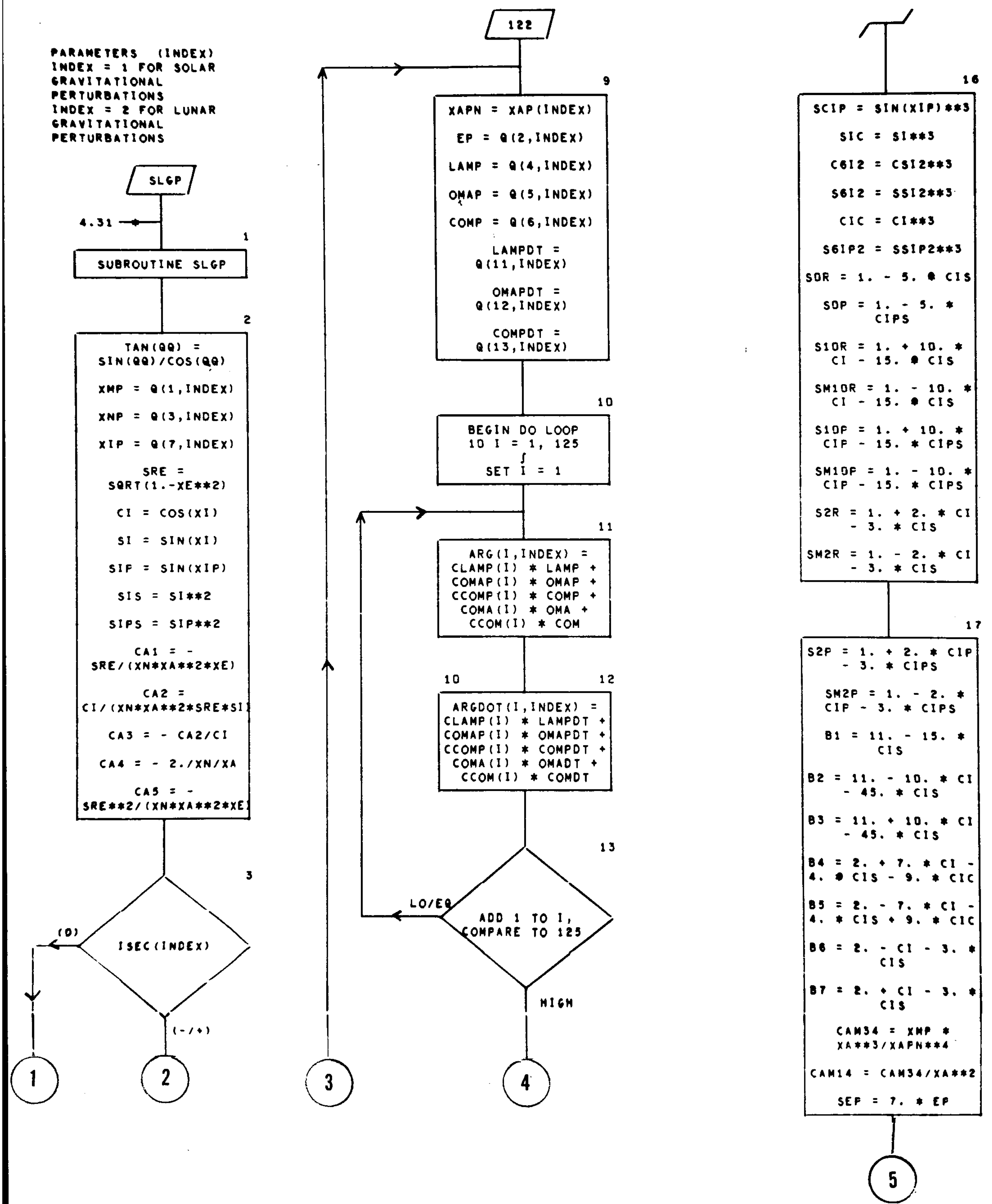
TABLE OF CONTENTS AND CROSS-REFERENCE LISTING

DECK SLGPD

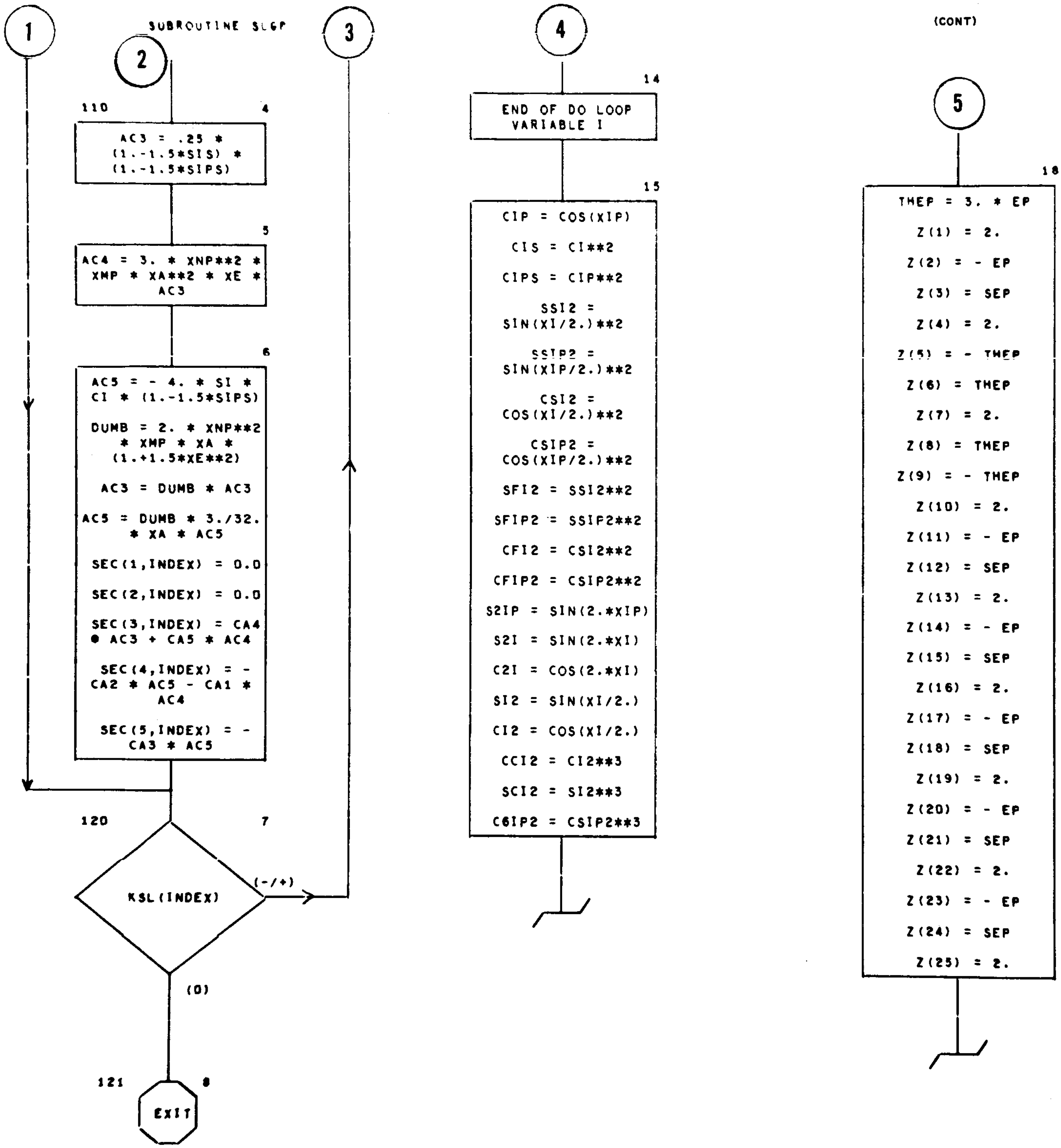
SUBROUTINE SLGP

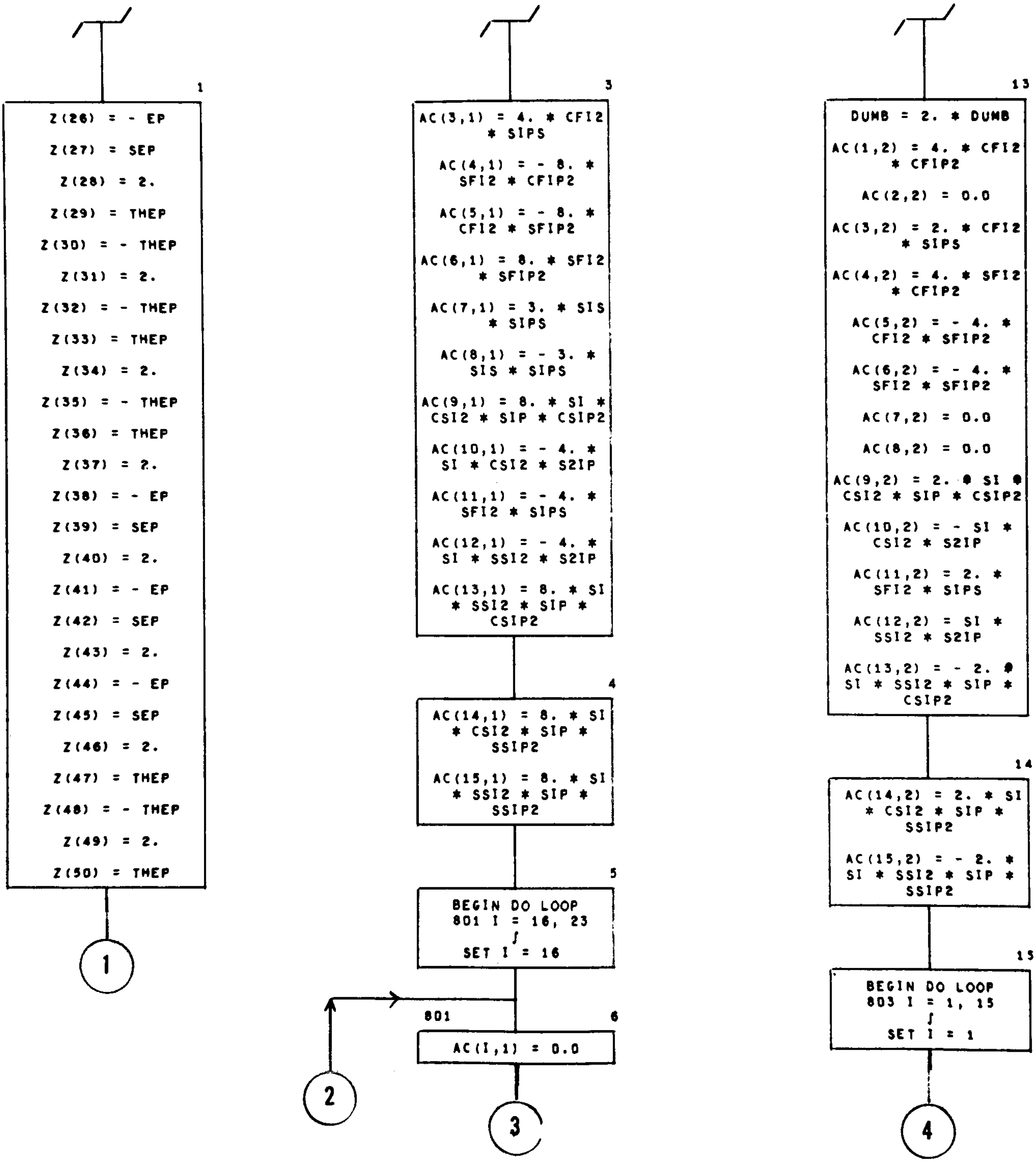
23.12	702	
23.15		23.24
23.17		23.22
23.21	710	
23.24	711	

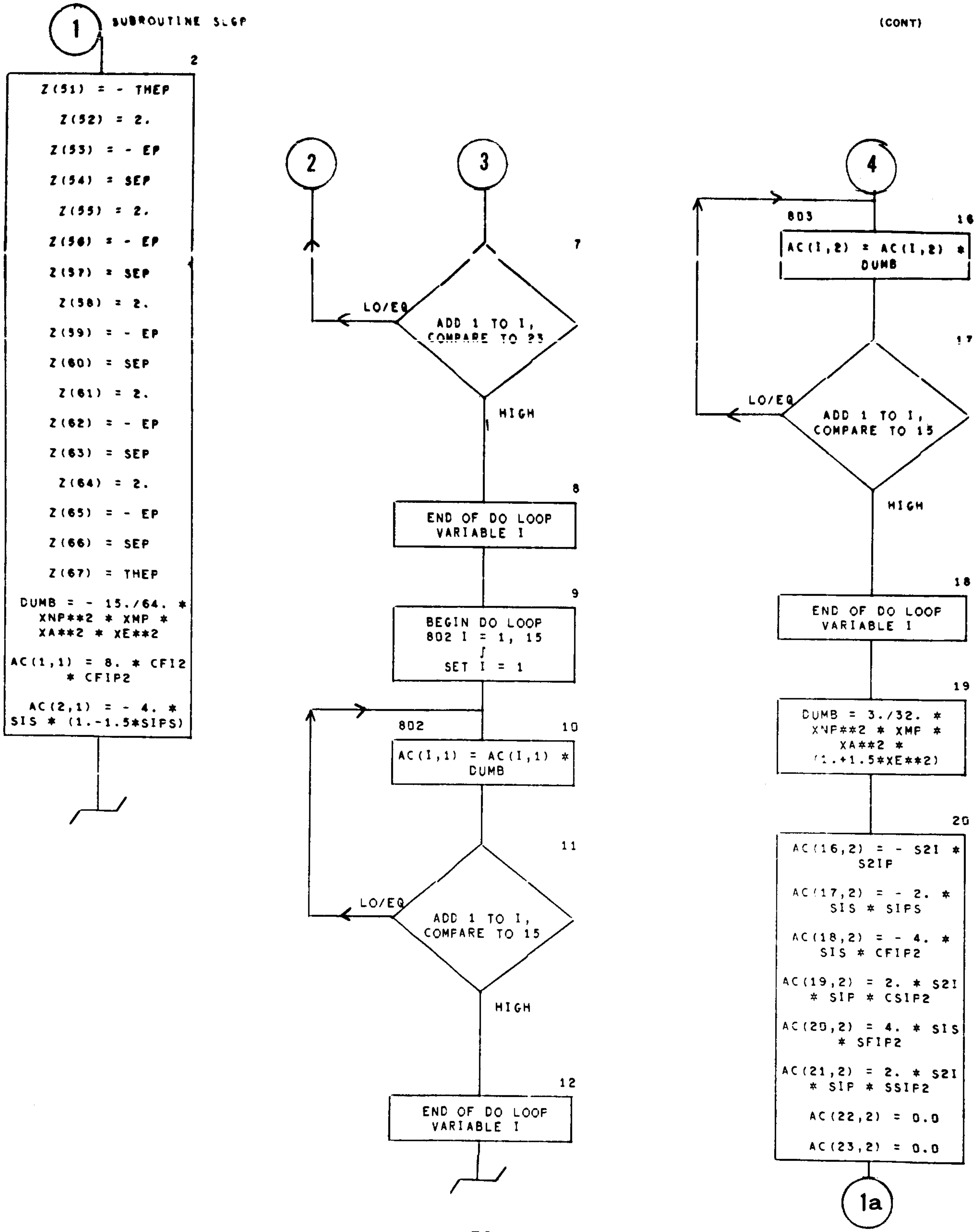
SUBROUTINE SLGP

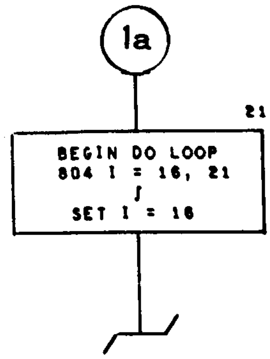


SUBROUTINE SLGP (CONT)

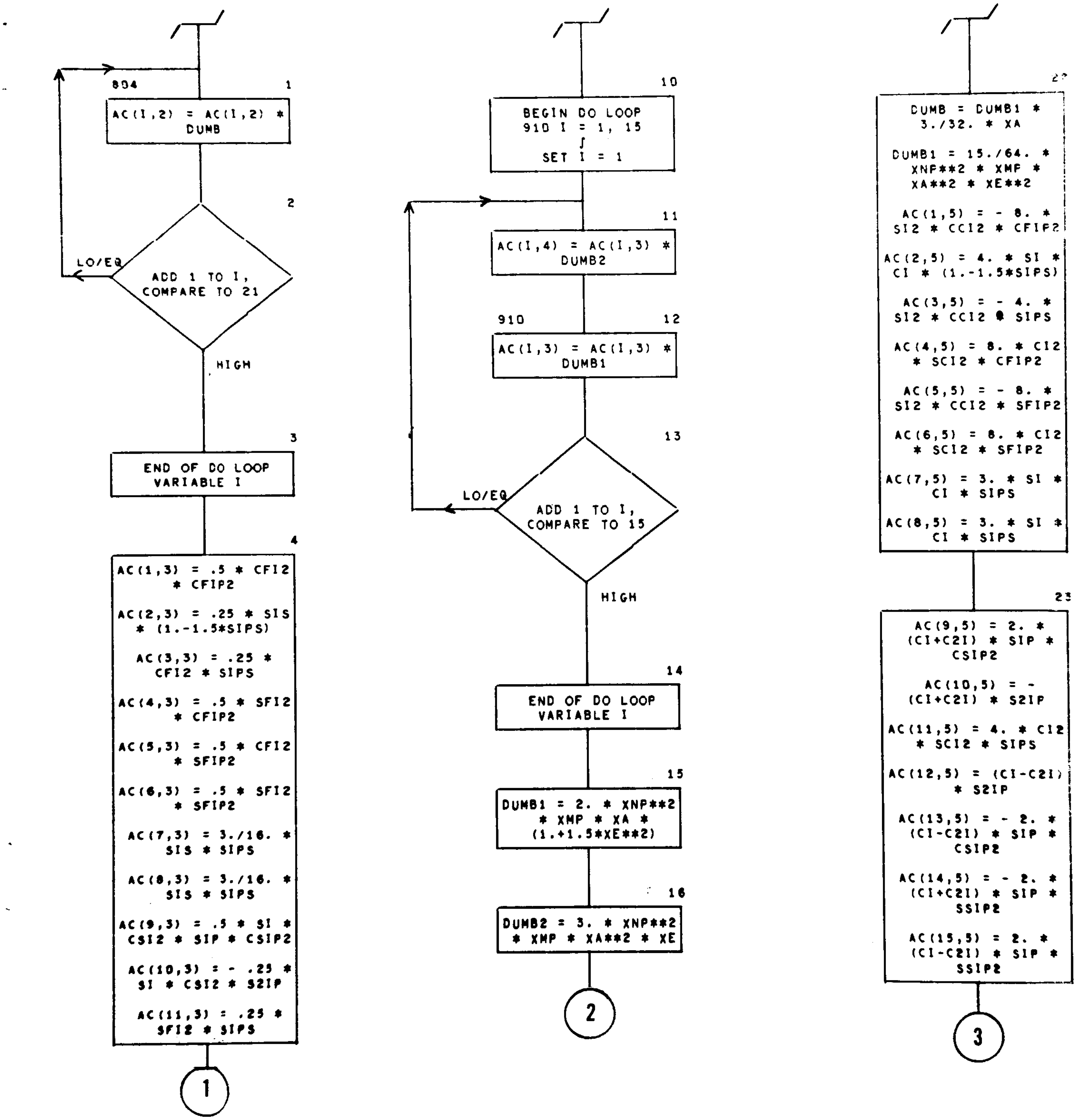



1
Z(26) = - EP
Z(27) = SEP
Z(28) = 2.
Z(29) = THEP
Z(30) = - THEP
Z(31) = 2.
Z(32) = - THEP
Z(33) = THEP
Z(34) = 2.
Z(35) = - THEP
Z(36) = THEP
Z(37) = 2.
Z(38) = - EP
Z(39) = SEP
Z(40) = 2.
Z(41) = - EP
Z(42) = SEP
Z(43) = 2.
Z(44) = - EP
Z(45) = SEP
Z(46) = 2.
Z(47) = THEP
Z(48) = - THEP
Z(49) = 2.
Z(50) = THEP
1
3
AC(3,1) = 4. * CFI2 * SIPS
AC(4,1) = - 8. * SFI2 * CFIP2
AC(5,1) = - 8. * CFI2 * SFIP2
AC(6,1) = 8. * SFI2 * SFIP2
AC(7,1) = 3. * SIS * SIPS
AC(8,1) = - 3. * SIS * SIPS
AC(9,1) = 8. * SI * CSI2 * SIP * CSIP2
AC(10,1) = - 4. * SI * CSI2 * S2IP
AC(11,1) = - 4. * SFI2 * SIPS
AC(12,1) = - 4. * SI * SSI2 * S2IP
AC(13,1) = 8. * SI * SSI2 * SIP * CSIP2
4
AC(14,1) = 8. * SI * CSI2 * SIP * SSIP2
AC(15,1) = 8. * SI * SSI2 * SIP * SSIP2
5
BEGIN DO LOOP 801 I = 16, 23
SET I = 16
801
6
AC(I,1) = 0.0
2
3
13
DUMB = 2. * DUMB
AC(1,2) = 4. * CFI2 * CFIP2
AC(2,2) = 0.0
AC(3,2) = 2. * CFI2 * SIPS
AC(4,2) = 4. * SFI2 * CFIP2
AC(5,2) = - 4. * CFI2 * SFIP2
AC(6,2) = - 4. * SFI2 * SFIP2
AC(7,2) = 0.0
AC(8,2) = 0.0
AC(9,2) = 2. * SI * CSI2 * SIP * CSIP2
AC(10,2) = - SI * CSI2 * S2IP
AC(11,2) = 2. * SFI2 * SIPS
AC(12,2) = SI * SSI2 * S2IP
AC(13,2) = - 2. * SI * SSI2 * SIP * CSIP2
14
AC(14,2) = 2. * SI * CSI2 * SIP * SSIP2
AC(15,2) = - 2. * SI * SSI2 * SIP * SSIP2
15
BEGIN DO LOOP 803 I = 1, 15
SET I = 1
4

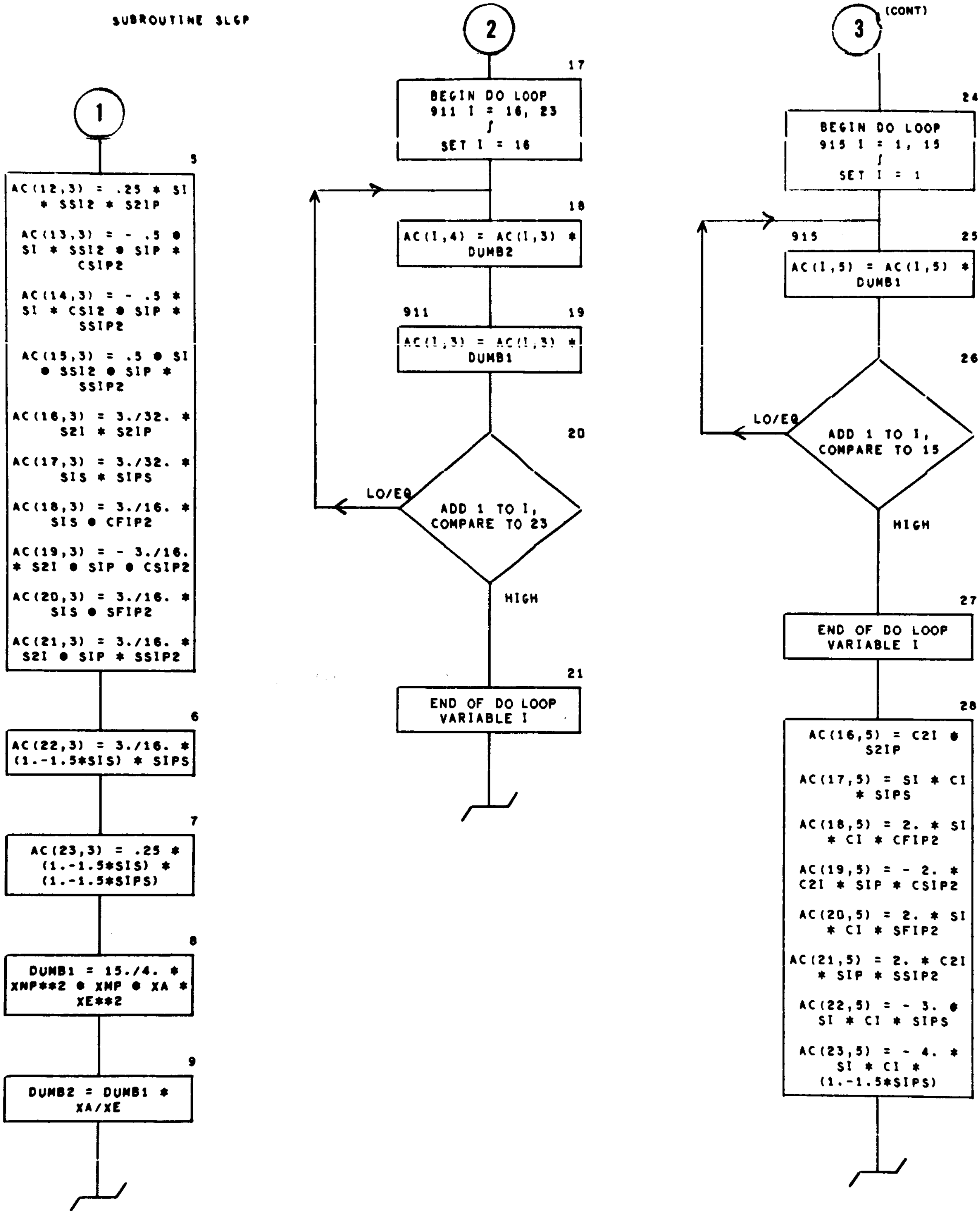

1
SUBROUTINE SLGP
2
Z(51) = - THEP
Z(52) = 2.
Z(53) = - EP
Z(54) = SEP
Z(55) = 2.
Z(56) = - EP
Z(57) = SEP
Z(58) = 2.
Z(59) = - EP
Z(60) = SEP
Z(61) = 2.
Z(62) = - EP
Z(63) = SEP
Z(64) = 2.
Z(65) = - EP
Z(66) = SEP
Z(67) = THEP
DUMB = - 15./64. * XNP**2 * XMP * XA**2 * XE**2
AC(1,1) = 8. * CFI2 * CFIP2
AC(2,1) = - 4. * SIS * (1.-1.5*SIPS)
2
3
7
LO/EQ
ADD 1 TO I, COMPARE TO 23
HIGH
8
END OF DO LOOP VARIABLE I
9
BEGIN DO LOOP 802 I = 1, 15
SET I = 1
802
10
AC(I,1) = AC(I,1) * DUMB
11
LO/EQ
ADD 1 TO I, COMPARE TO 15
HIGH
12
END OF DO LOOP VARIABLE I
4
803
16
AC(I,2) = AC(I,2) * DUMB
17
LO/EQ
ADD 1 TO I, COMPARE TO 15
HIGH
18
END OF DO LOOP VARIABLE I
19
DUMB = 3./32. * XNP**2 * XMP * XA**2 * (1.+1.5*XE**2)
20
AC(16,2) = - S2I * S2IP
AC(17,2) = - 2. * SIS * SIPS
AC(18,2) = - 4. * SIS * CFIP2
AC(19,2) = 2. * S2I * SIP * CSIP2
AC(20,2) = 4. * SIS * SFIP2
AC(21,2) = 2. * S2I * SIP * SSIP2
AC(22,2) = 0.0
AC(23,2) = 0.0
1a

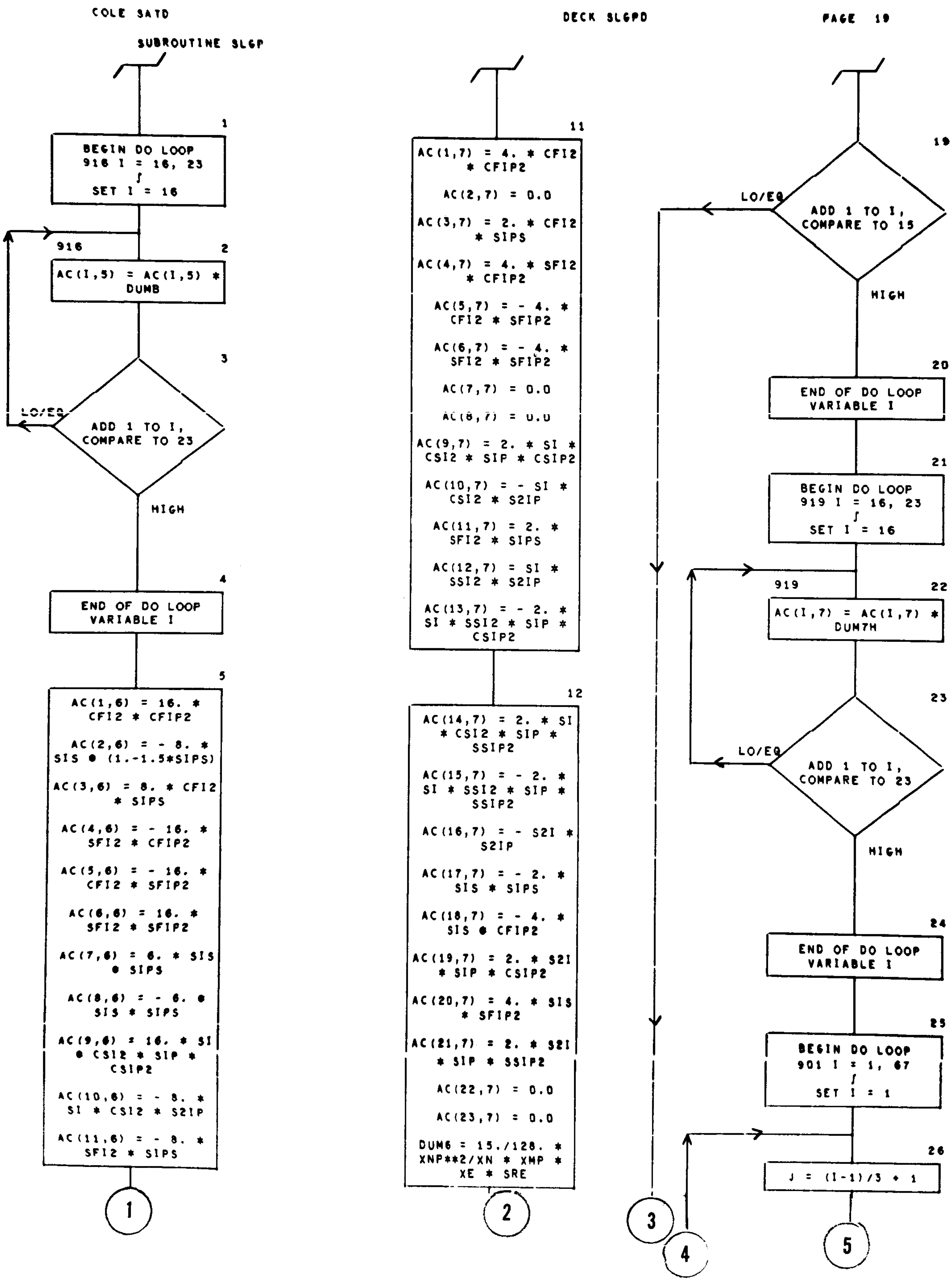

1a
21
BEGIN DO LOOP
804 I = 16, 21
SET I = 16

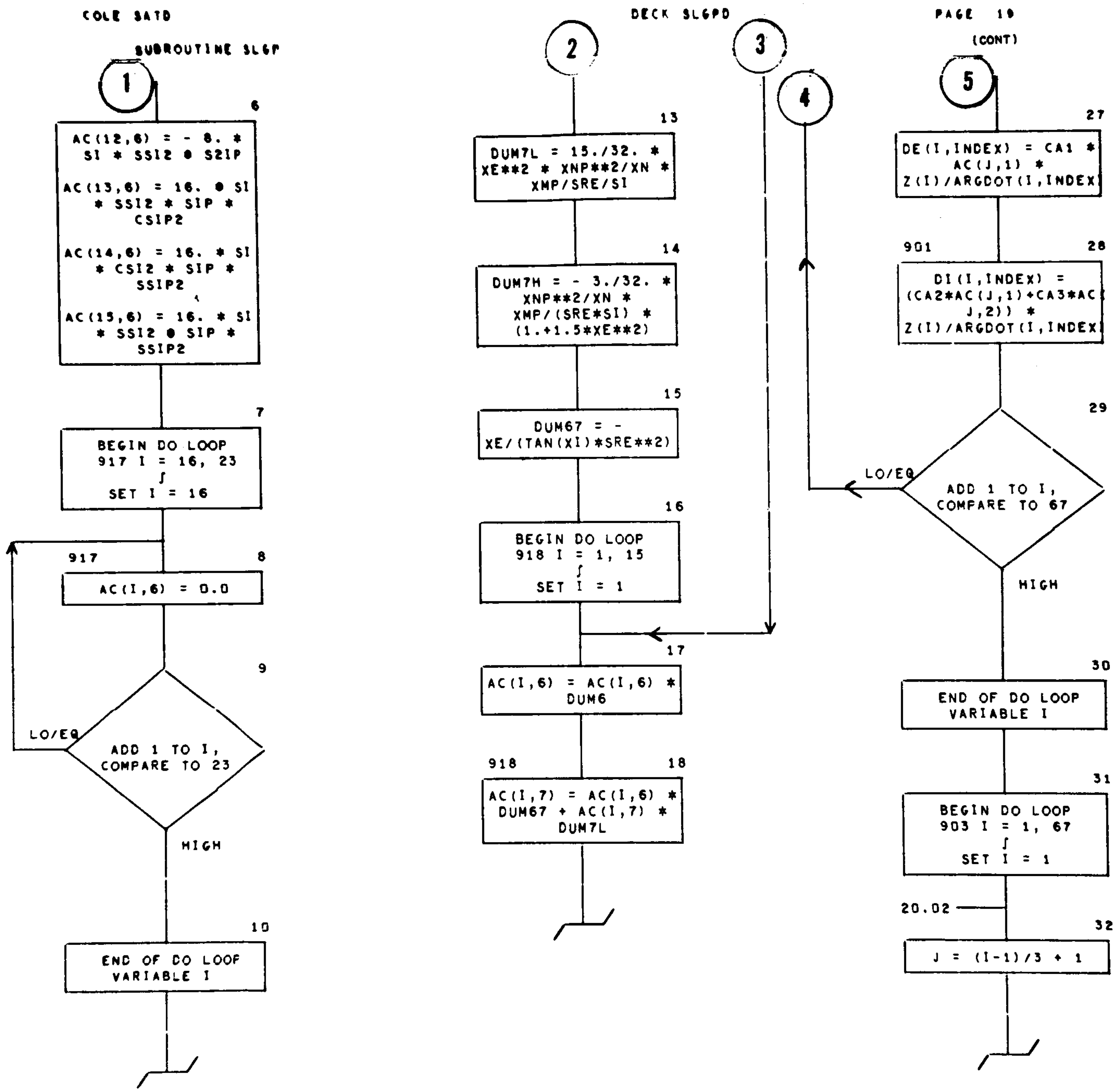
SUBROUTINE SLGP



SUBROUTINE SLGP

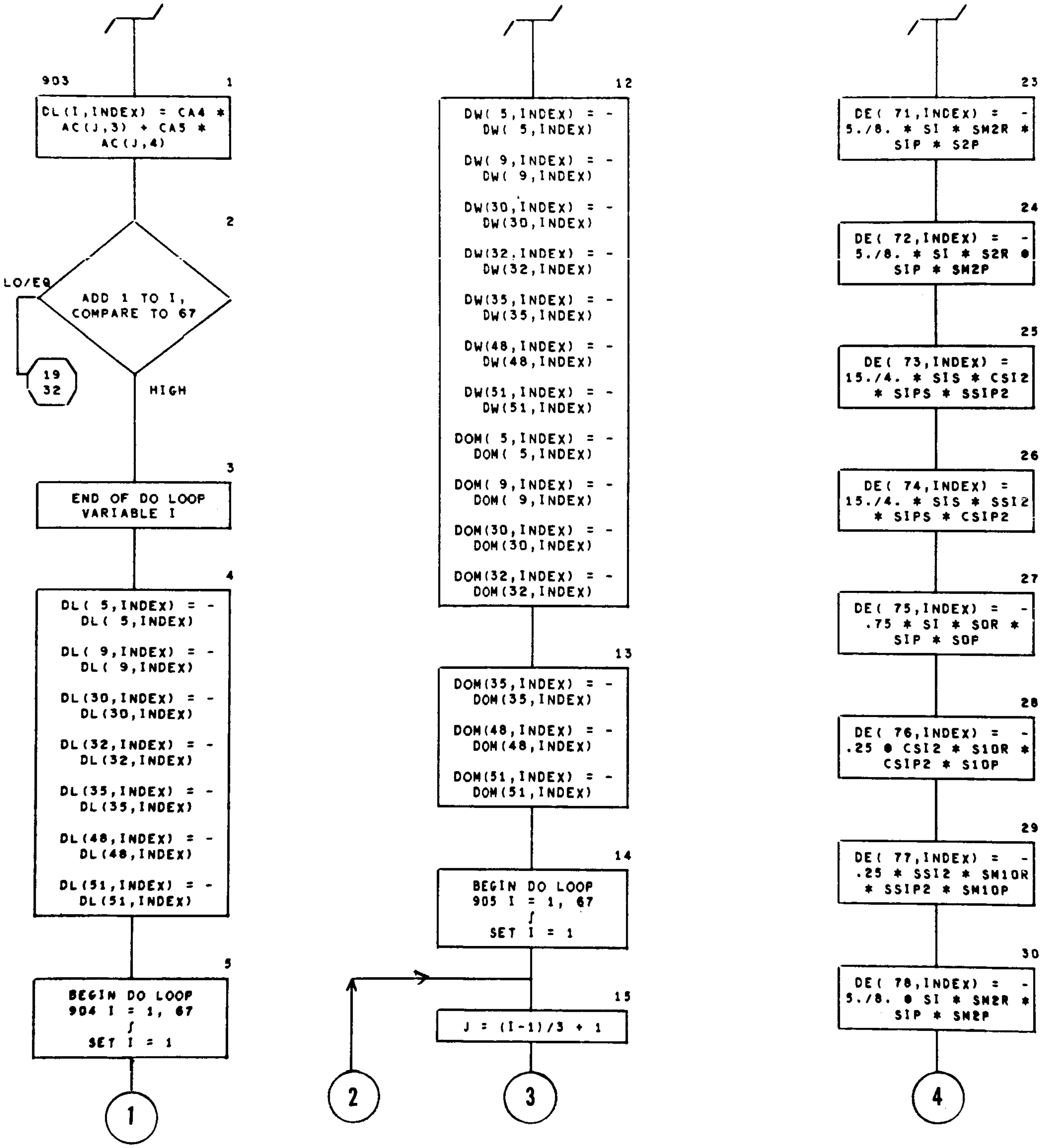


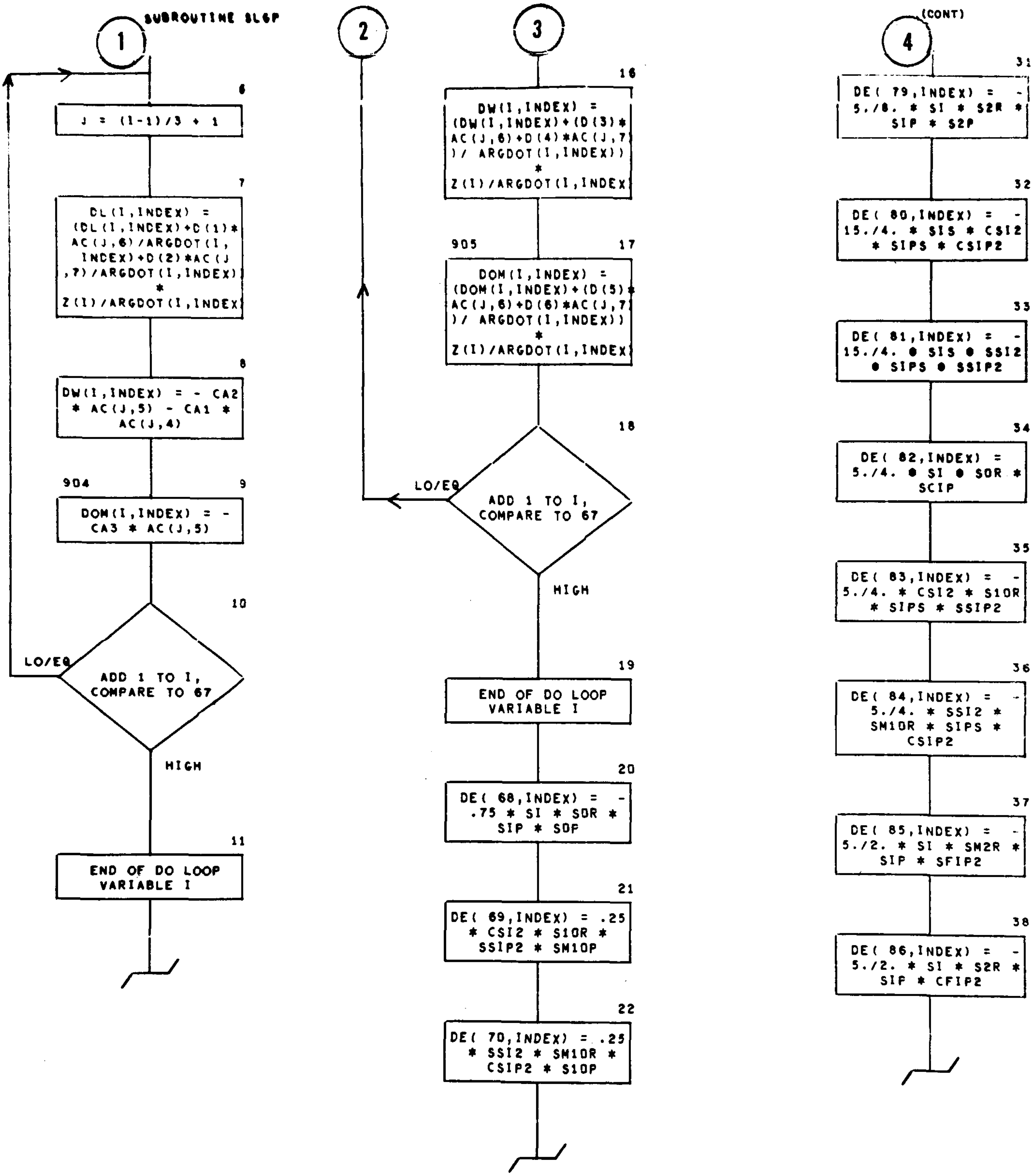

COLE SATD
DECK SLGPD
PAGE 19
SUBROUTINE SLGP
1
BEGIN DO LOOP
916 I = 16, 23
SET I = 16
916
2
AC(I,5) = AC(I,5) * DUMB
3
ADD 1 TO I, COMPARE TO 23
LO/EQ
HIGH
4
END OF DO LOOP VARIABLE I
5
AC(1,6) = 16. * CFI2 * CFIP2
AC(2,6) = - 8. * SIS * (1.-1.5*SIPS)
AC(3,6) = 8. * CFI2 * SIPS
AC(4,6) = - 16. * SFI2 * CFIP2
AC(5,6) = - 16. * CFI2 * SFIP2
AC(6,6) = 16. * SFI2 * SFIP2
AC(7,6) = 6. * SIS * SIPS
AC(8,6) = - 6. * SIS * SIPS
AC(9,6) = 16. * SI * CSI2 * SIP * CSIP2
AC(10,6) = - 8. * SI * CSI2 * S2IP
AC(11,6) = - 8. * SFI2 * SIPS
1
11
AC(1,7) = 4. * CFI2 * CFIP2
AC(2,7) = 0.0
AC(3,7) = 2. * CFI2 * SIPS
AC(4,7) = 4. * SFI2 * CFIP2
AC(5,7) = - 4. * CFI2 * SFIP2
AC(6,7) = - 4. * SFI2 * SFIP2
AC(7,7) = 0.0
AC(8,7) = 0.0
AC(9,7) = 2. * SI * CSI2 * SIP * CSIP2
AC(10,7) = - SI * CSI2 * S2IP
AC(11,7) = 2. * SFI2 * SIPS
AC(12,7) = SI * SSI2 * S2IP
AC(13,7) = - 2. * SI * SSI2 * SIP * CSIP2
12
AC(14,7) = 2. * SI * CSI2 * SIP * SSIP2
AC(15,7) = - 2. * SI * SSI2 * SIP * SSIP2
AC(16,7) = - S2I * S2IP
AC(17,7) = - 2. * SIS * SIPS
AC(18,7) = - 4. * SIS * CFIP2
AC(19,7) = 2. * S2I * SIP * CSIP2
AC(20,7) = 4. * SIS * SFIP2
AC(21,7) = 2. * S2I * SIP * SSIP2
AC(22,7) = 0.0
AC(23,7) = 0.0
DUM6 = 15./128. * XNP**2/XN * XMP * XE * SRE
2
19
ADD 1 TO I, COMPARE TO 15
LO/EQ
HIGH
3
20
END OF DO LOOP VARIABLE I
21
BEGIN DO LOOP
919 I = 16, 23
SET I = 16
919
22
AC(I,7) = AC(I,7) * DUM7H
23
ADD 1 TO I, COMPARE TO 23
LO/EQ
HIGH
24
END OF DO LOOP VARIABLE I
25
BEGIN DO LOOP
901 I = 1, 67
SET I = 1
4
26
J = (I-1)/3 + 1
5



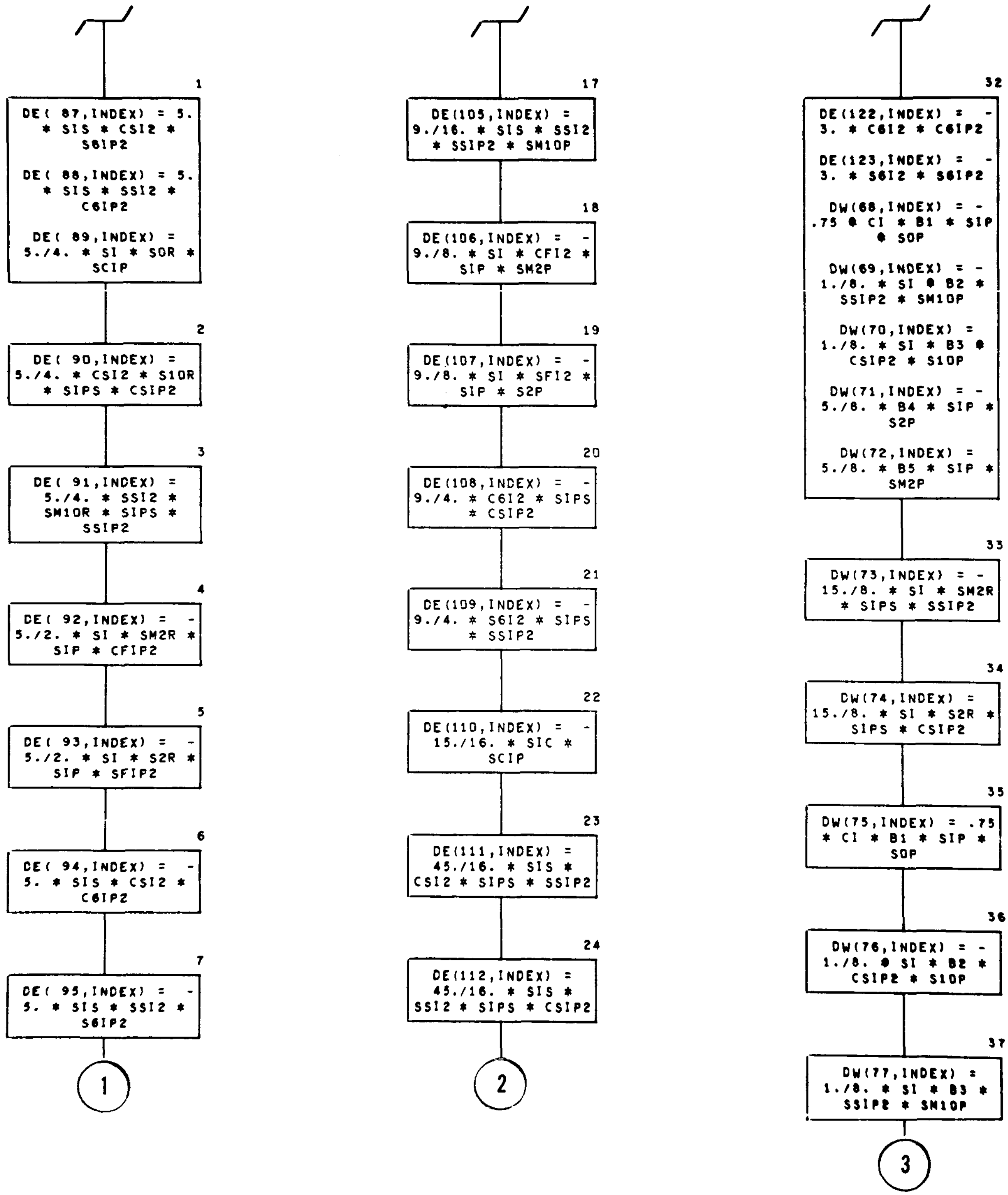
CODE SATD
SUBROUTINE SLGP
DECK SLGPD
PAGE 19
(CONT)
1
6
AC(12,6) = - 8. * SI * SSI2 * S2IP
AC(13,6) = 16. * SI * SSI2 * SIP * CSIP2
AC(14,6) = 16. * SI * CSI2 * SIP * SSIP2
AC(15,6) = 16. * SI * SSI2 * SIP * SSIP2
7
BEGIN DO LOOP 917 I = 16, 23 ∫ SET I = 16
917
8
AC(I,6) = 0.0
9
LO/EQ
ADD 1 TO I, COMPARE TO 23
HIGH
10
END OF DO LOOP VARIABLE I
2
13
DUM7L = 15./32. * XE**2 * XNP**2/XN * XMP/SRE/SI
14
DUM7H = - 3./32. * XNP**2/XN * XMP/(SRE*SI) * (1.+1.5*XE**2)
15
DUM67 = - XE/(TAN(XI)*SRE**2)
16
BEGIN DO LOOP 918 I = 1, 15 ∫ SET I = 1
3
17
AC(I,6) = AC(I,6) * DUM6
918
18
AC(I,7) = AC(I,6) * DUM67 + AC(I,7) * DUM7L
4
5
27
DE(I,INDEX) = CA1 * AC(J,1) * Z(I)/ARGDOT(I,INDEX)
901
28
DI(I,INDEX) = (CA2*AC(J,1)+CA3*AC(J,2)) * Z(I)/ARGDOT(I,INDEX)
29
LO/EQ
ADD 1 TO I, COMPARE TO 67
HIGH
30
END OF DO LOOP VARIABLE I
31
BEGIN DO LOOP 903 I = 1, 67 ∫ SET I = 1
20.02
32
J = (I-1)/3 + 1

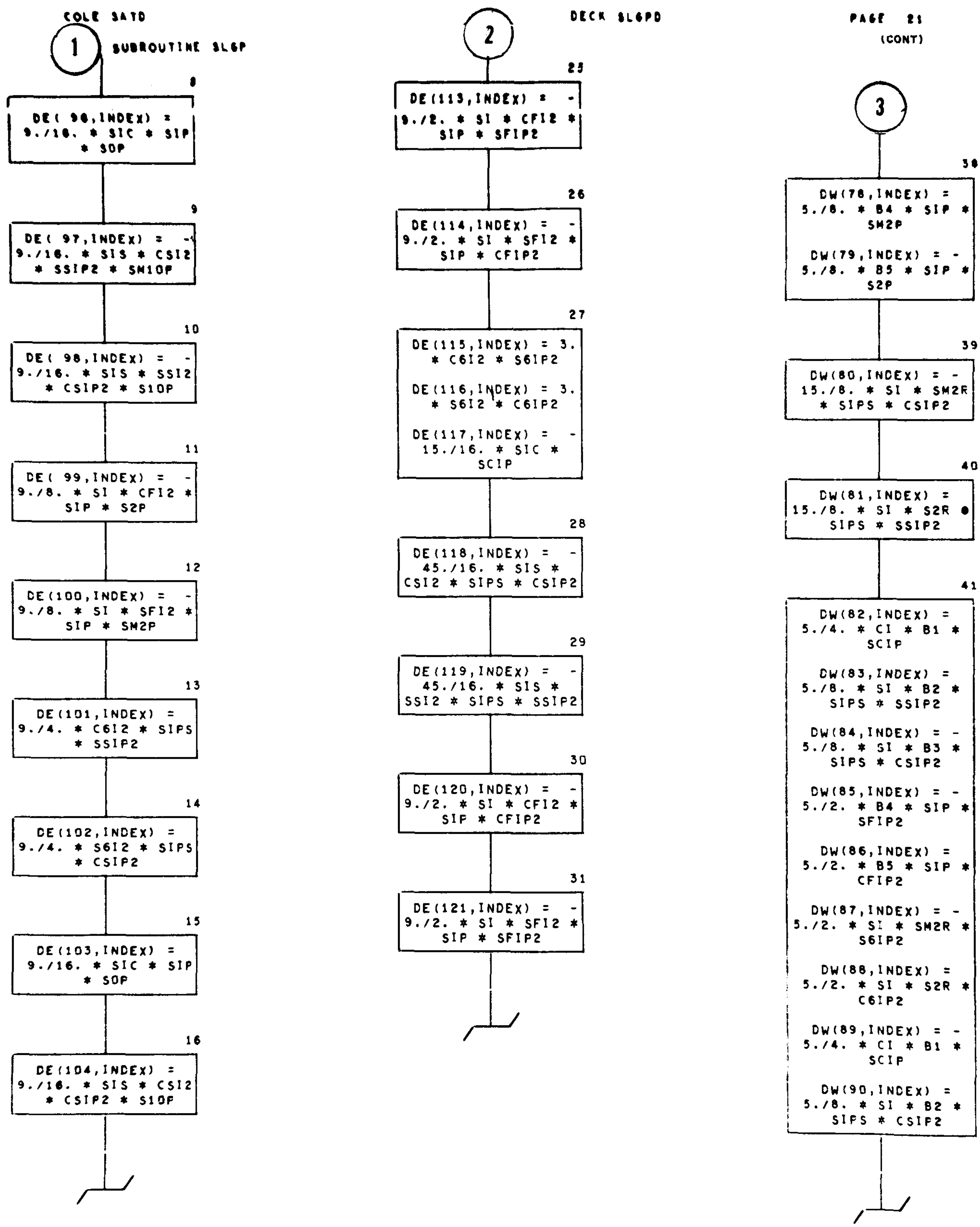
SUBROUTINE SLGP



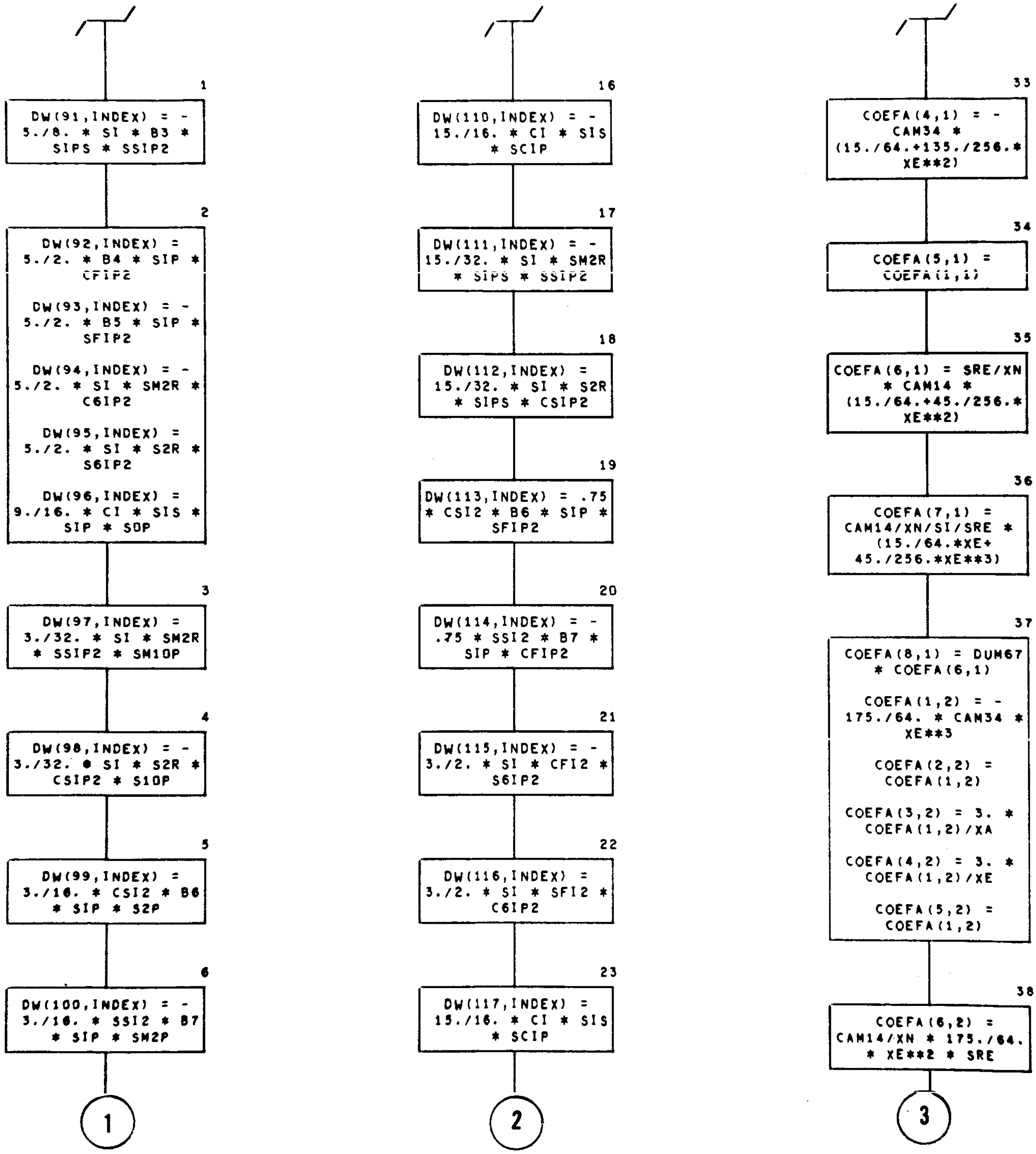

SUBROUTINE SLGP
(CONT)
1
6
J = (I-1)/3 + 1
7
DL(I,INDEX) = (DL(I,INDEX)+D(1)* AC(J,6)/ARGDOT(I, INDEX)+D(2)*AC(J ,7)/ARGDOT(I,INDEX)) * Z(I)/ARGDOT(I,INDEX)
8
DW(I,INDEX) = - CA2 * AC(J,5) - CA1 * AC(J,4)
904
9
DOM(I,INDEX) = - CA3 * AC(J,5)
10
LO/EQ
ADD 1 TO I, COMPARE TO 67
HIGH
11
END OF DO LOOP VARIABLE I
2
3
16
DW(I,INDEX) = (DW(I,INDEX)+(D(3)* AC(J,6)+D(4)*AC(J,7))/ ARGDOT(I,INDEX)) * Z(I)/ARGDOT(I,INDEX)
905
17
DOM(I,INDEX) = (DOM(I,INDEX)+(D(5)* AC(J,6)+D(6)*AC(J,7))/ ARGDOT(I,INDEX)) * Z(I)/ARGDOT(I,INDEX)
18
LO/EQ
ADD 1 TO I, COMPARE TO 67
HIGH
19
END OF DO LOOP VARIABLE I
20
DE(68,INDEX) = - .75 * SI * SOR * SIP * SOP
21
DE(69,INDEX) = .25 * CSI2 * S1OR * SSIP2 * SM1OP
22
DE(70,INDEX) = .25 * SSI2 * SM1OR * CSIP2 * S1OP
4
31
DE(79,INDEX) = - 5./8. * SI * S2R * SIP * S2P
32
DE(80,INDEX) = - 15./4. * SIS * CSI2 * SIPS * CSIP2
33
DE(81,INDEX) = - 15./4. * SIS * SSI2 * SIPS * SSIP2
34
DE(82,INDEX) = 5./4. * SI * SOR * SCIP
35
DE(83,INDEX) = - 5./4. * CSI2 * S1OR * SIPS * SSIP2
36
DE(84,INDEX) = - 5./4. * SSI2 * SM1OR * SIPS * CSIP2
37
DE(85,INDEX) = - 5./2. * SI * SM2R * SIP * SFIP2
38
DE(86,INDEX) = - 5./2. * SI * S2R * SIP * CFIP2

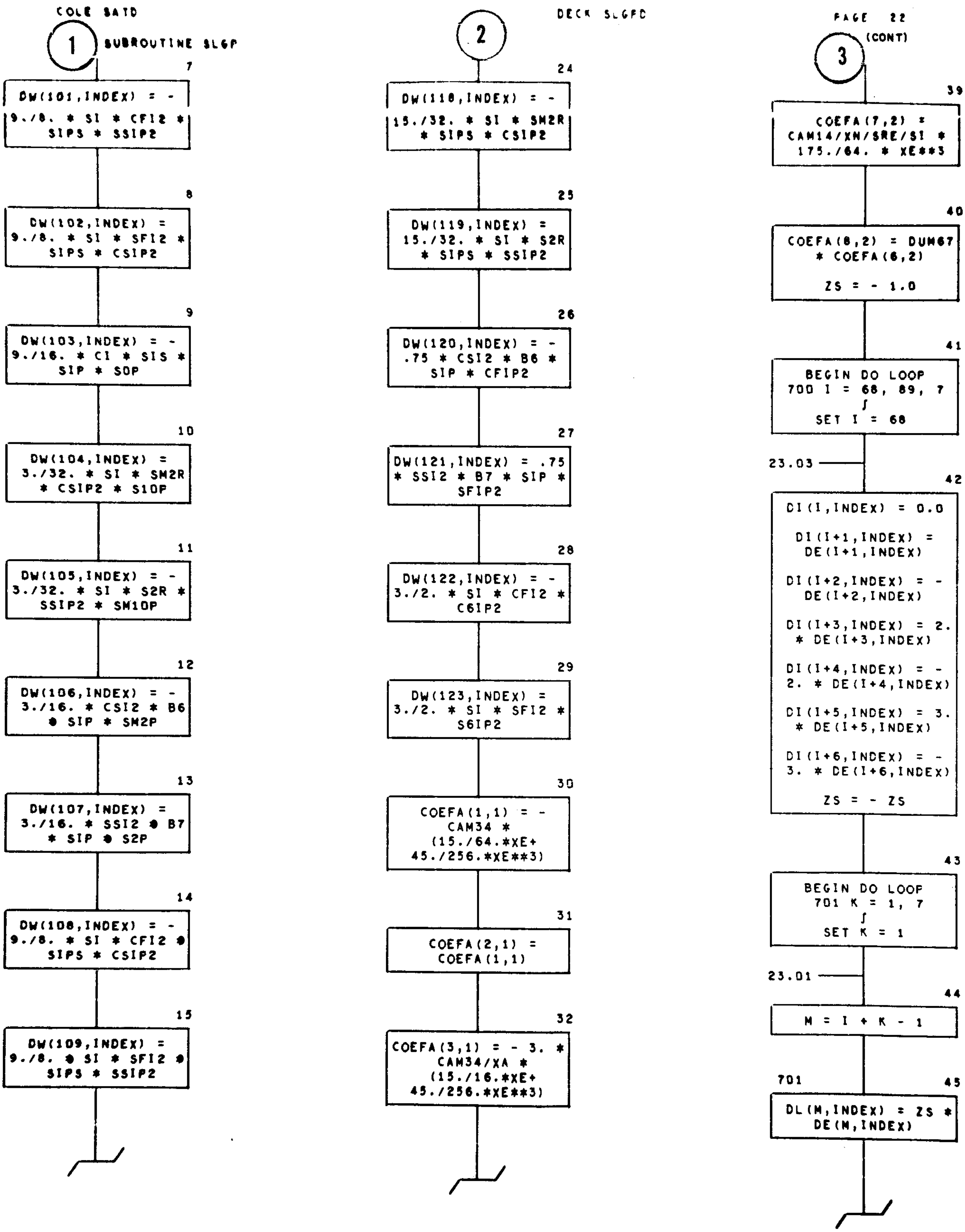
SUBROUTINE SLGP




CODE SATD
1
SUBROUTINE SLGP
8
DE(96,INDEX) = 9./16. * SIC * SIP * SOP
9
DE(97,INDEX) = -9./16. * SIS * CSI2 * SSIP2 * SM1OP
10
DE(98,INDEX) = -9./16. * SIS * SSI2 * CSIP2 * S1OP
11
DE(99,INDEX) = -9./8. * SI * CFI2 * SIP * S2P
12
DE(100,INDEX) = -9./8. * SI * SFI2 * SIP * SM2P
13
DE(101,INDEX) = 9./4. * C6I2 * SIPS * SSIP2
14
DE(102,INDEX) = 9./4. * S6I2 * SIPS * CSIP2
15
DE(103,INDEX) = 9./16. * SIC * SIP * SOP
16
DE(104,INDEX) = 9./16. * SIS * CSI2 * CSIP2 * S1OP
2
DECK SLGPD
25
DE(113,INDEX) = -9./2. * SI * CFI2 * SIP * SFIP2
26
DE(114,INDEX) = -9./2. * SI * SFI2 * SIP * CFIP2
27
DE(115,INDEX) = 3. * C6I2 * S6IP2
DE(116,INDEX) = 3. * S6I2 * C6IP2
DE(117,INDEX) = -15./16. * SIC * SCIP
28
DE(118,INDEX) = -45./16. * SIS * CSI2 * SIPS * CSIP2
29
DE(119,INDEX) = -45./16. * SIS * SSI2 * SIPS * SSIP2
30
DE(120,INDEX) = -9./2. * SI * CFI2 * SIP * CFIP2
31
DE(121,INDEX) = -9./2. * SI * SFI2 * SIP * SFIP2
PAGE 21
(CONT)
3
38
DW(78,INDEX) = 5./8. * B4 * SIP * SM2P
DW(79,INDEX) = -5./8. * B5 * SIP * S2P
39
DW(80,INDEX) = -15./8. * SI * SM2R * SIPS * CSIP2
40
DW(81,INDEX) = 15./8. * SI * S2R * SIPS * SSIP2
41
DW(82,INDEX) = 5./4. * CI * B1 * SCIP
DW(83,INDEX) = 5./8. * SI * B2 * SIPS * SSIP2
DW(84,INDEX) = -5./8. * SI * B3 * SIPS * CSIP2
DW(85,INDEX) = -5./2. * B4 * SIP * SFIP2
DW(86,INDEX) = 5./2. * B5 * SIP * CFIP2
DW(87,INDEX) = -5./2. * SI * SM2R * S6IP2
DW(88,INDEX) = 5./2. * SI * S2R * C6IP2
DW(89,INDEX) = -5./4. * CI * B1 * SCIP
DW(90,INDEX) = 5./8. * SI * B2 * SIPS * CSIP2

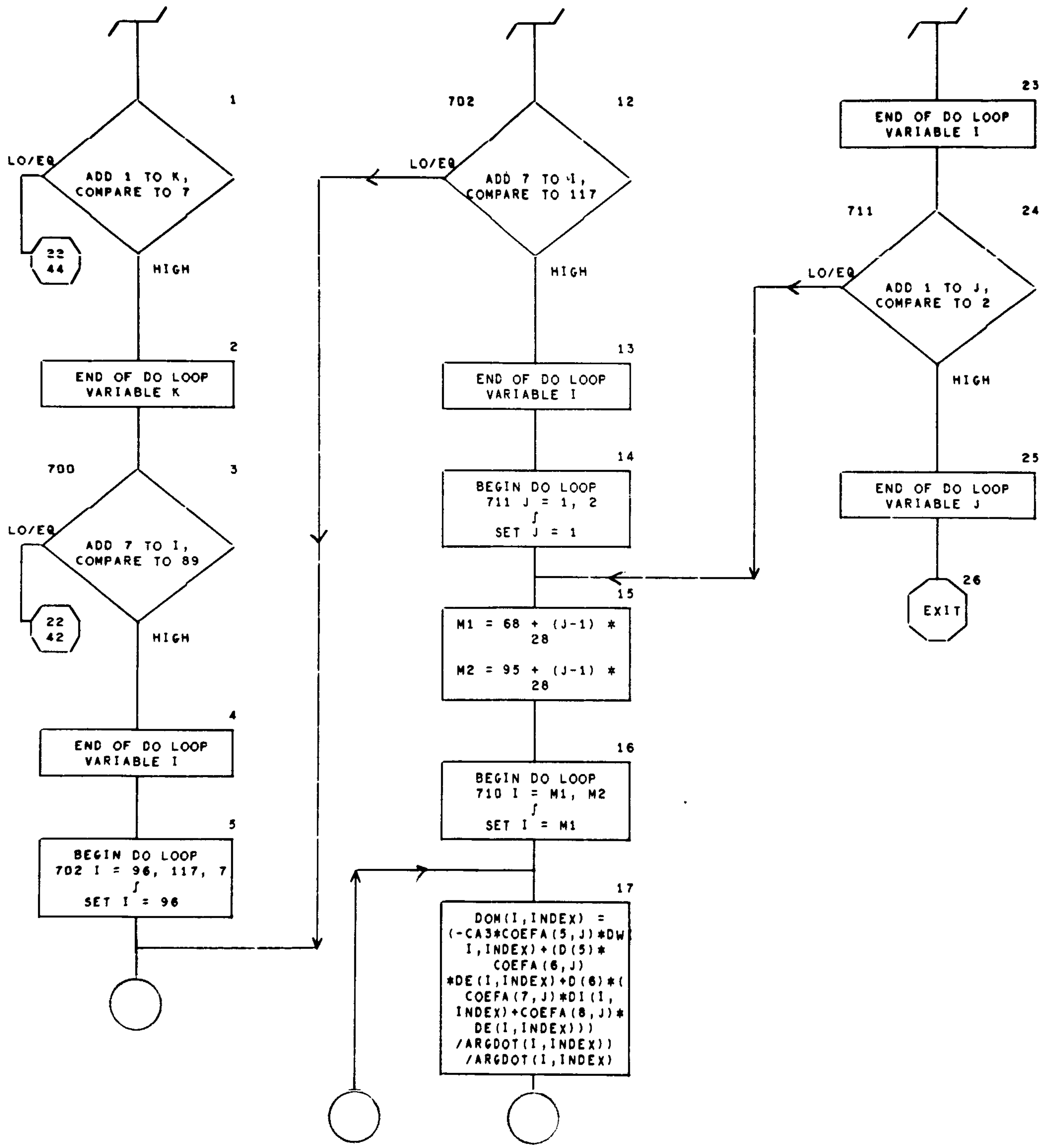
SUBROUTINE SLGP

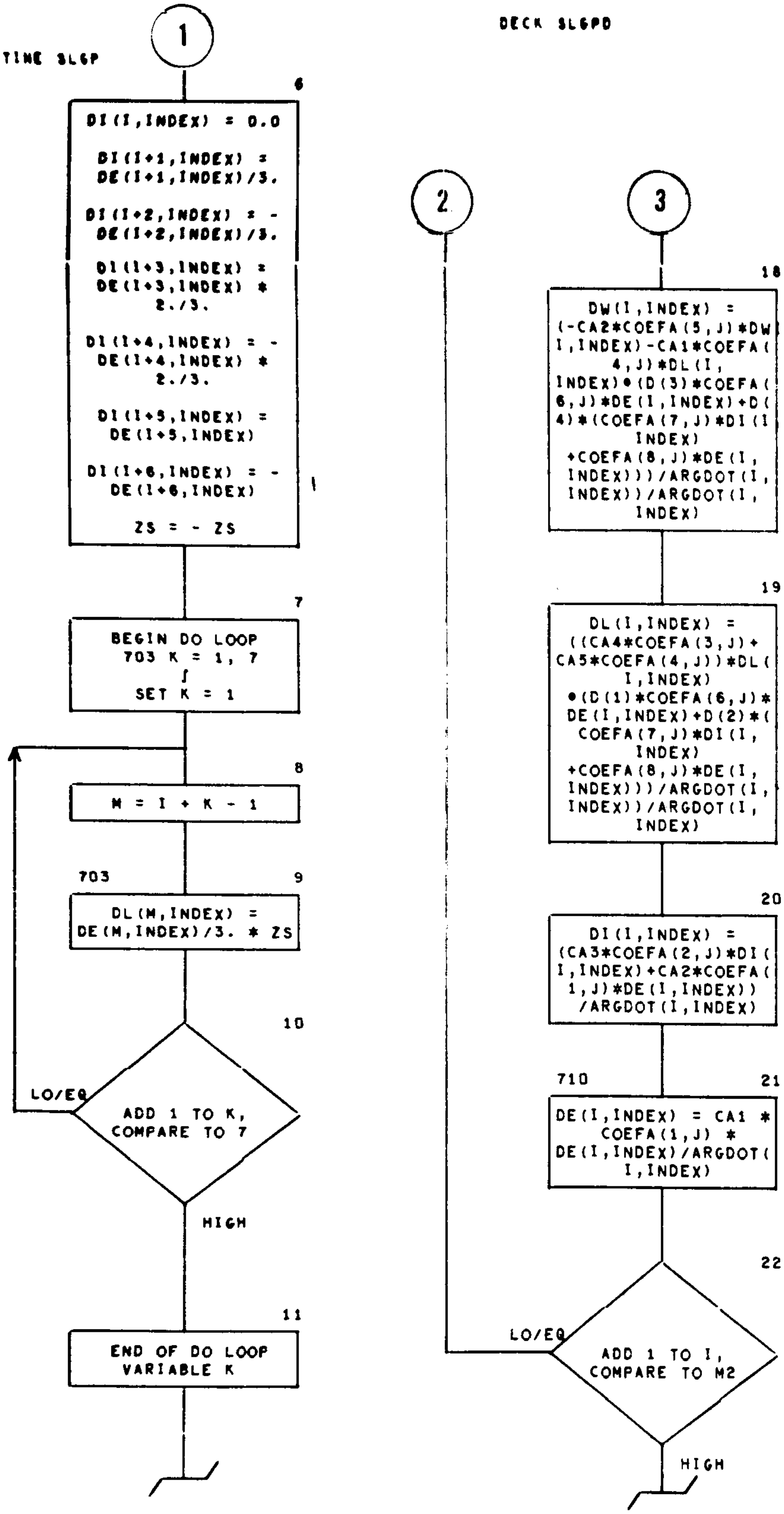




CODE SATD
1
SUBROUTINE SLGP
7
DW(101,INDEX) = - 9./8. * SI * CFI2 * SIPS * SSIP2
8
DW(102,INDEX) = 9./8. * SI * SFI2 * SIPS * CSIP2
9
DW(103,INDEX) = - 9./16. * CI * SIS * SIP * SOP
10
DW(104,INDEX) = 3./32. * SI * SM2R * CSIP2 * S10P
11
DW(105,INDEX) = - 3./32. * SI * S2R * SSIP2 * SM10P
12
DW(106,INDEX) = - 3./16. * CSI2 * B6 * SIP * SM2P
13
DW(107,INDEX) = 3./16. * SSI2 * B7 * SIP * S2P
14
DW(108,INDEX) = - 9./8. * SI * CFI2 * SIPS * CSIP2
15
DW(109,INDEX) = 9./8. * SI * SFI2 * SIPS * SSIP2
2
DECK SLGPD
24
DW(118,INDEX) = - 15./32. * SI * SM2R * SIPS * CSIP2
25
DW(119,INDEX) = 15./32. * SI * S2R * SIPS * SSIP2
26
DW(120,INDEX) = - .75 * CSI2 * B6 * SIP * CFIP2
27
DW(121,INDEX) = .75 * SSI2 * B7 * SIP * SFIP2
28
DW(122,INDEX) = - 3./2. * SI * CFI2 * C6IP2
29
DW(123,INDEX) = 3./2. * SI * SFI2 * S6IP2
30
COEFA(1,1) = - CAM34 * (15./64.*XE+ 45./256.*XE**3)
31
COEFA(2,1) = COEFA(1,1)
32
COEFA(3,1) = - 3. * CAM34/XA * (15./16.*XE+ 45./256.*XE**3)
PAGE 22
(CONT)
3
39
COEFA(7,2) = CAM14/XN/SRE/SI * 175./64. * XE**3
40
COEFA(8,2) = DUM67 * COEFA(6,2)
ZS = - 1.0
41
BEGIN DO LOOP 700 I = 68, 89, 7
SET I = 68
23.03
42
DI(I,INDEX) = 0.0
DI(I+1,INDEX) = DE(I+1,INDEX)
DI(I+2,INDEX) = - DE(I+2,INDEX)
DI(I+3,INDEX) = 2. * DE(I+3,INDEX)
DI(I+4,INDEX) = - 2. * DE(I+4,INDEX)
DI(I+5,INDEX) = 3. * DE(I+5,INDEX)
DI(I+6,INDEX) = - 3. * DE(I+6,INDEX)
ZS = - ZS
43
BEGIN DO LOOP 701 K = 1, 7
SET K = 1
23.01
44
M = I + K - 1
701
45
DL(M,INDEX) = ZS * DE(M,INDEX)

SUBROUTINE SLGP




1
6
DI(I,INDEX) = 0.0
DI(I+1,INDEX) = DE(I+1,INDEX)/3.
DI(I+2,INDEX) = - DE(I+2,INDEX)/3.
DI(I+3,INDEX) = DE(I+3,INDEX) * 2./3.
DI(I+4,INDEX) = - DE(I+4,INDEX) * 2./3.
DI(I+5,INDEX) = DE(I+5,INDEX)
DI(I+6,INDEX) = - DE(I+6,INDEX)
ZS = - ZS
7
BEGIN DO LOOP 703 K = 1, 7 SET K = 1
8
M = I + K - 1
703
9
DL(M,INDEX) = DE(M,INDEX)/3. * ZS
10
LO/EQ
ADD 1 TO K, COMPARE TO 7
HIGH
11
END OF DO LOOP VARIABLE K
2
3
18
DW(I,INDEX) = (-CA2*COEFA(5,J)*DW(I,INDEX)-CA1*COEFA(4,J)*DL(I,INDEX)*(D(3)*COEFA(6,J)*DE(I,INDEX)+D(4)*(COEFA(7,J)*DI(I,INDEX)+COEFA(8,J)*DE(I,INDEX)))/ARGDOT(I,INDEX))/ARGDOT(I,INDEX)
19
DL(I,INDEX) = ((CA4*COEFA(3,J)+CA5*COEFA(4,J))*DL(I,INDEX)*(D(1)*COEFA(6,J)*DE(I,INDEX)+D(2)*(COEFA(7,J)*DI(I,INDEX)+COEFA(8,J)*DE(I,INDEX)))/ARGDOT(I,INDEX))/ARGDOT(I,INDEX)
20
DI(I,INDEX) = (CA3*COEFA(2,J)*DI(I,INDEX)+CA2*COEFA(1,J)*DE(I,INDEX))/ARGDOT(I,INDEX)
710
21
DE(I,INDEX) = CA1 * COEFA(1,J) * DE(I,INDEX)/ARGDOT(I,INDEX)
22
LO/EQ
ADD 1 TO I, COMPARE TO M2
HIGH

IX. SUBROUTINE BCDSO

B C D information, specifically the period or amplitude of the long period terms computed by subroutine SLGP, is sorted by this subroutine. (See page 25 of Reference 1.)

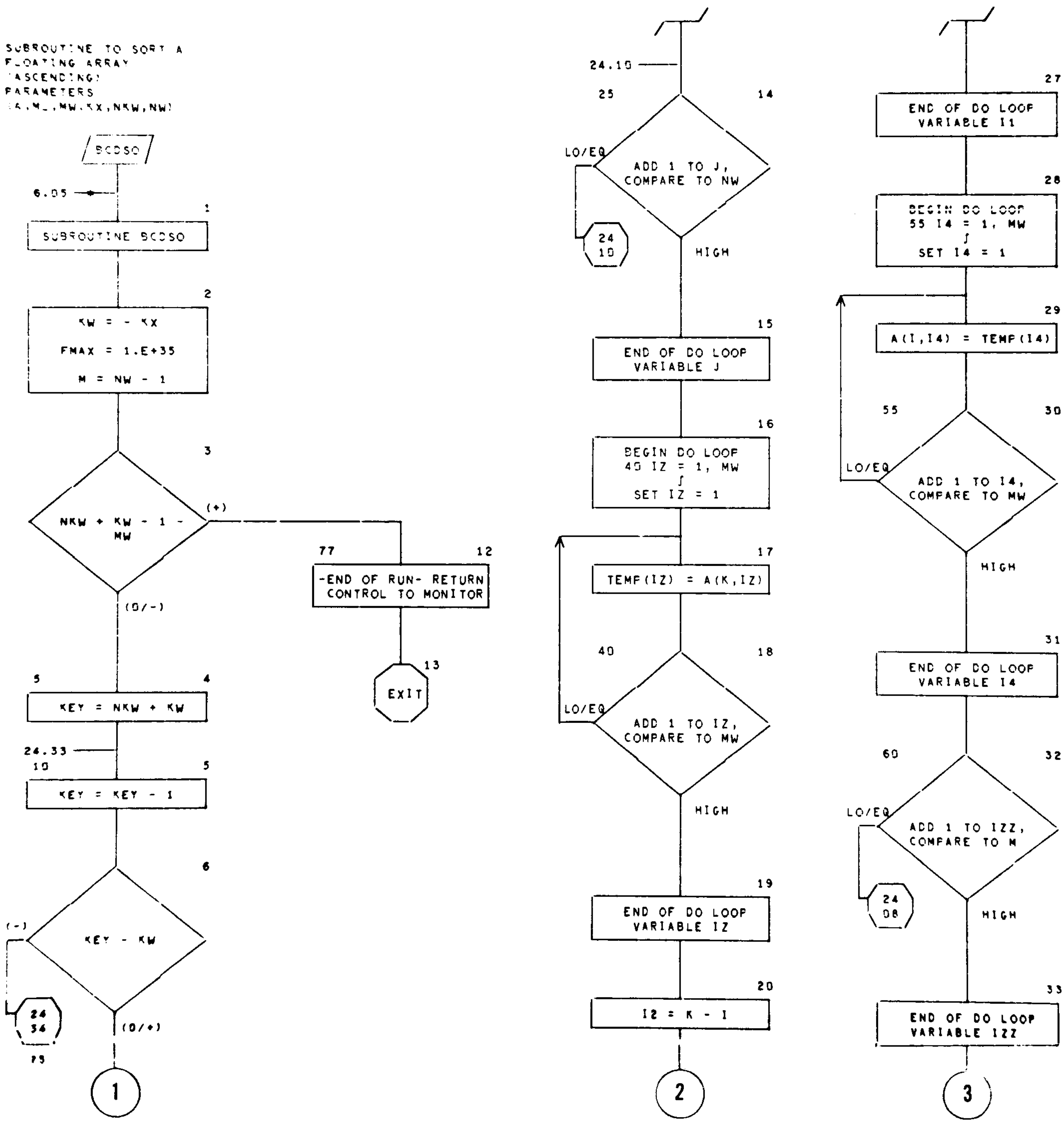
```
DECK BCDSO
      DIMENSION A(ML,MW)
      DIMENSION TEMP(20)
```

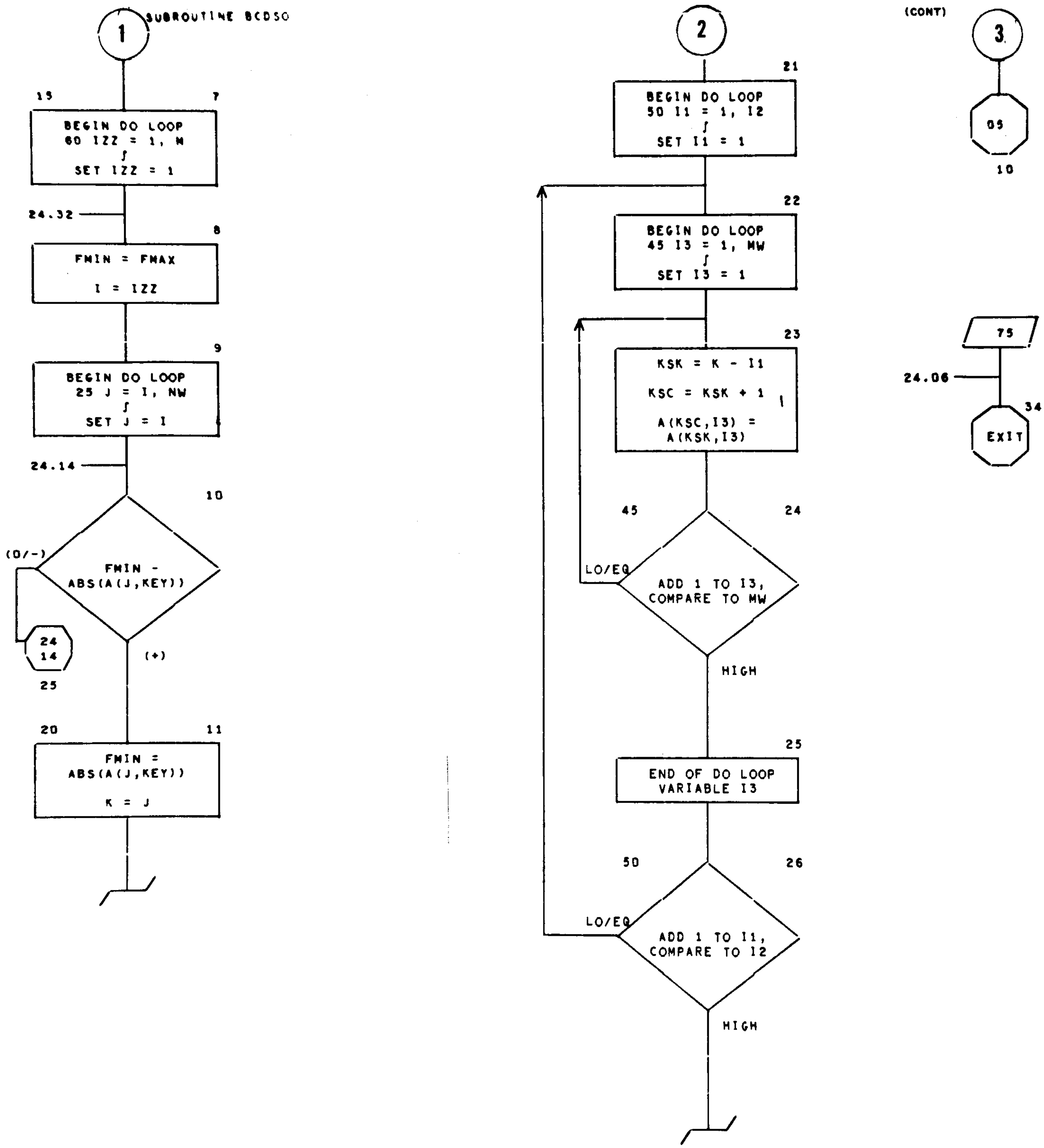
DECK BCDSO

SUBROUTINE BCDSO

24.01	BCDSO	6.05*	7.24*
24.04	5		
24.05	10	24.33	
24.07	15		
24.08		24.32	
24.10		24.14	
24.11	20		
24.12	77	24.03	
24.14	25	24.10	
24.17		24.18	
24.18	40		
24.22		24.26	
24.23		24.24	
24.24	45		
24.26	50		
24.29		24.30	
24.30	55		
24.32	60		
24.34	75	24.06	

SUBROUTINE BCDSO




SUBROUTINE BCDSO
1
15
7
BEGIN DO LOOP
60 IZZ = 1, N
SET IZZ = 1
24.32
8
FMIN = FMAX
I = IZZ
9
BEGIN DO LOOP
25 J = I, NW
SET J = I
24.14
10
(0/-)
FMIN - ABS(A(J,KEY))
24
14
25
(+)
20
11
FMIN = ABS(A(J,KEY))
K = J
2
21
BEGIN DO LOOP
50 I1 = 1, I2
SET I1 = 1
22
BEGIN DO LOOP
45 I3 = 1, MW
SET I3 = 1
23
KSK = K - I1
KSC = KSK + 1
A(KSC,I3) = A(KSK,I3)
45
24
LO/EQ
ADD 1 TO I3, COMPARE TO MW
HIGH
25
END OF DO LOOP
VARIABLE I3
50
26
LO/EQ
ADD 1 TO I1, COMPARE TO I2
HIGH
3
05
10
75
24.06
34
EXIT

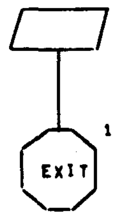
X. SUBROUTINE DATA

This subroutine contains data only—this data is used by subroutines SRP, SLGP and the main program. The data in this subroutine is presented here. (See page 24 of Reference 1.)

DECK DATAD

```
      COMMON/RAD/P(6,6),B(6,6)
      COMMON /COEF/ CLAMP(125),COMAP(125),CCOMP(125),COMA(125),CCOM(125)
```

THIS IS A BLOCK DATA DECK




```
BLOCK DATA

      DATA(CLAMP(I),I = 1,67)/2.,1.,3.,0.,1.,1.,0.,1.,1.,2.,
      1.,3.,2.,1.,3.,2.,1.,3.,2.,1.,3.,2.,1.,3.,2.,1.,3.,0.,1.,
      1.,0.,1.,1.,0.,1.,1.,2.,1.,3.,2.,1.,3.,2.,1.,3.,0.,1.,1.,0.,
      1.,1.,2.,1.,3.,2.,1.,3.,2.,1.,3.,2.,1.,3.,2.,1.,3.,1./

      DATA(COMAP(I),I = 1,67)/0.,1.,-1.,0.,-1.,-1.,0.,-1.,-1.,
      0.,1.,-1.,0.,1.,-1.,0.,1.,-1.,0.,1.,-1.,0.,1.,-1.,0.,1.,-1.,
      0.,-1.,-1.,0.,-1.,-1.,0.,-1.,-1.,0.,1.,-1.,0.,1.,-1.,0.,
      1.,-1.,0.,-1.,-1.,0.,-1.,-1.,0.,1.,-1.,0.,1.,-1.,0.,1.,-1.,
      0.,1.,-1.,0.,1.,-1.,-1./

      DATA(CCOMP(I),I = 1,67)/0.,1.,-1.,0.,-1.,-1.,2.,1.,-3.,0.,
      1.,-1.,-4.,-3.,-5.,-4.,-3.,-5.,-2.,-1.,-3.,-2.,-1.,-3.,
      -1.,0.,-2.,1.,0.,-2.,2.,-3.,1.,1.,-2.,0.,-1.,0.,-2.,-3.,
      -2.,-4.,-3.,-2.,-4.,1.,0.,-2.,2.,1.,-3.,0.,1.,-1.,-1.,0.,-2.,
      -4.,-3.,-5.,-3.,-2.,-4.,-2.,-1.,-3.,-1./

      DATA(COMA(I),I = 1,67)/-2.,-2.,-2.,2.,-2.,2.,-2.,-2.,
      2.,2.,2.,2.,2.,2.,2.,-2.,-2.,-2.,-2.,-2.,-2.,2.,2.,
      2.,-2.,-2.,-2.,-2.,-2.,2.,2.,-2.,2.,2.,-2.,2.,2.,2.,
      2.,2.,2.,2.,-2.,-2.,-2.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,
      0.,0.,0.,0.,0.,0.,0.,0.,0. /

      DATA(CCOM(I),I = 1,67)/-2.,-2.,-2.,0.,0.,0.,-2.,-2.,2.,
      -2.,-2.,-2.,2.,2.,2.,2.,2.,2.,0.,0.,0.,0.,0.,0.,-1.,-1.,-1.,
          -1.,-1.,1.,-2.,2.,-2.,-1.,1.,-1.,-1.,-1.,-1.,1.,1.,1.,1.,1.,

      DATA((B(I,J),I=1,6),J=1,3)/8*1.,-1.,-1.,0.,0.,1.,-1.,1.,-1.,1.,-1.
```

```
DATA(CCQM(I),I = 1,67)/-2.,-2.,-2.,0.,0.,0.,-2.,-2.,2.,
-2.,-2.,-2.,2.,2.,2.,2.,2.,2.,0.,0.,0.,0.,0.,0.,-1.,-1.,-1.,
     -1.,-1.,1.,-2.,2.,-2.,-1.,1.,-1.,-1.,-1.,-1.,1.,1.,1.,1.,1.,
1.,-1.,-1.,1.,-2.,-2.,2.,-2.,-2.,-2.,-1.,-1.,-1.,2.,2.,2.,1.,1.,
1.,0.,0.,0.,0./

DATA(CLAMP(I),I=68,125)/14*1.0,14*3.0,14*1.0,14*3.0,2*0.0/

DATA(COMAP(I),I=68,125)/58*0.0/

DATA(CCOMP(I),I=68,125)/-1.0,-2.0,0.0,-3.0,1.0,-4.0,
2.0,-1.0,0.0,-2.0,1.0,-3.0,2.0,-4.0,-3.0,-4.0,-2.0,
-5.0,-1.0,-6.0,0.0,-3.0,-2.0,-4.0,-1.0,-5.0,0.0,-6.0,
-1.0,-2.0,0.0,-3.0,1.0,-4.0,2.0,-1.0,0.0,-2.0,1.0,-3.0,
2.0,-4.0,-3.0,-4.0,-2.0,-5.0,-1.0,-6.0,0.0,-3.0,
-2.0,-4.0,-1.0,-5.0,0.0,-6.0,0.0,0.0/

DATA(COMA(I),I=68,125)/7*1.0,7*-1.0,7*1.0,
7*-1.0,7*3.0,7*-3.0,7*3.0,7*-3.0,0.0,0.0/

DATA(CCOM(I),I=68,125)/0.0,1.0,-1.0,2.0,-2.0,3.0,
-3.0,0.0,-1.0,1.0,-2.0,2.0,-3.0,3.0,0.0,1.0,-1.0,2.0,
-2.0,3.0,-3.0,0.0,-1.0,1.0,-2.0,2.0,-3.0,3.0,0.0,
1.0,-1.0,2.0,-2.0,3.0,-3.0,0.0,-1.0,1.0,-2.0,2.0,
-3.0,3.0,0.0,1.0,-1.0,2.0,-2.0,3.0,-3.0,0.0,-1.0,1.0,
-2.0,2.0,-3.0,3.0,0.0,0.0/
```

XI. SUBROUTINE RDBIN

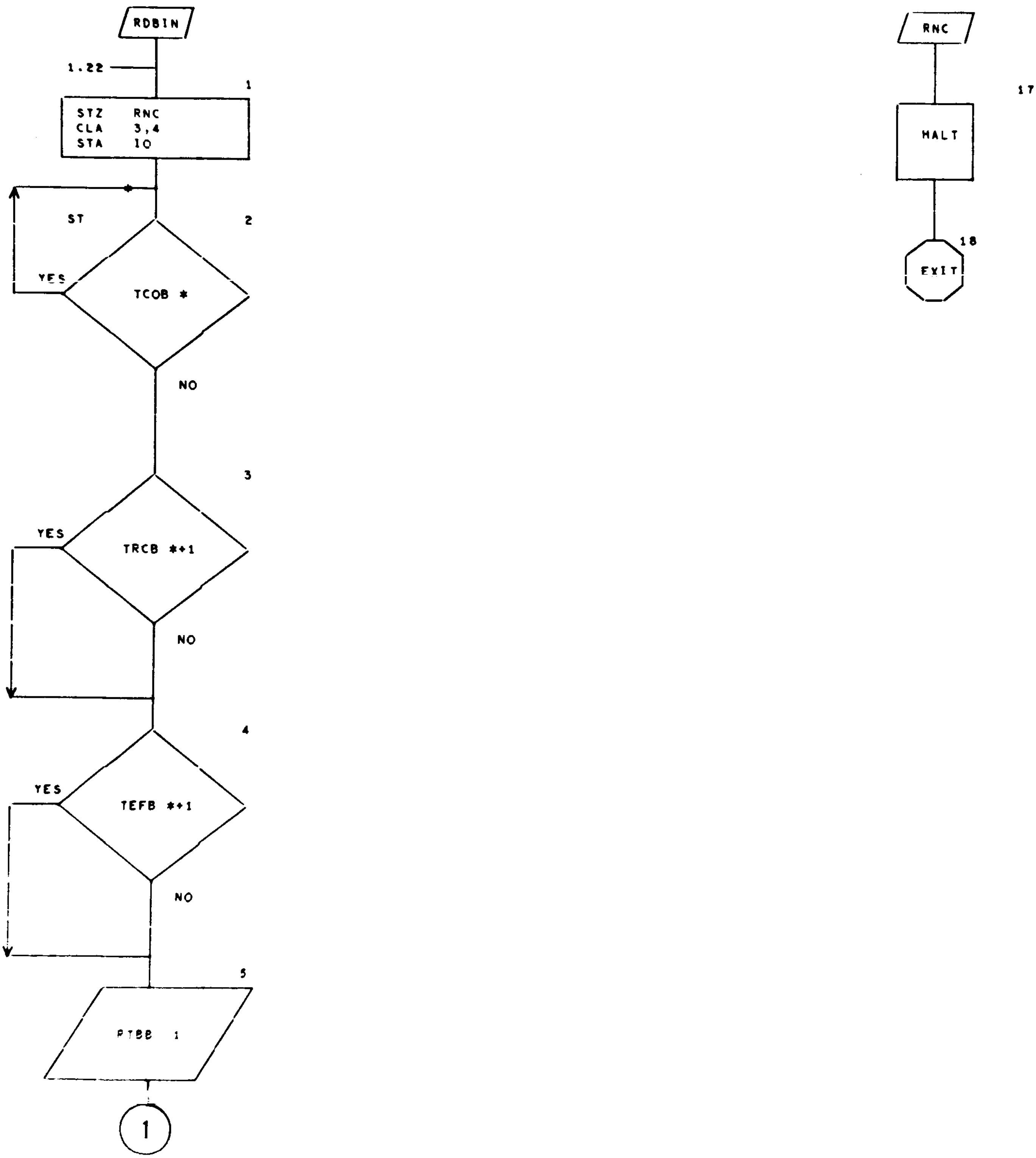
The Read binary subroutine reads a 100 word binary input tape that does not have as word one a fixed point word, i.e., a non-Fortran type record. (See page 23 of Reference 1.)

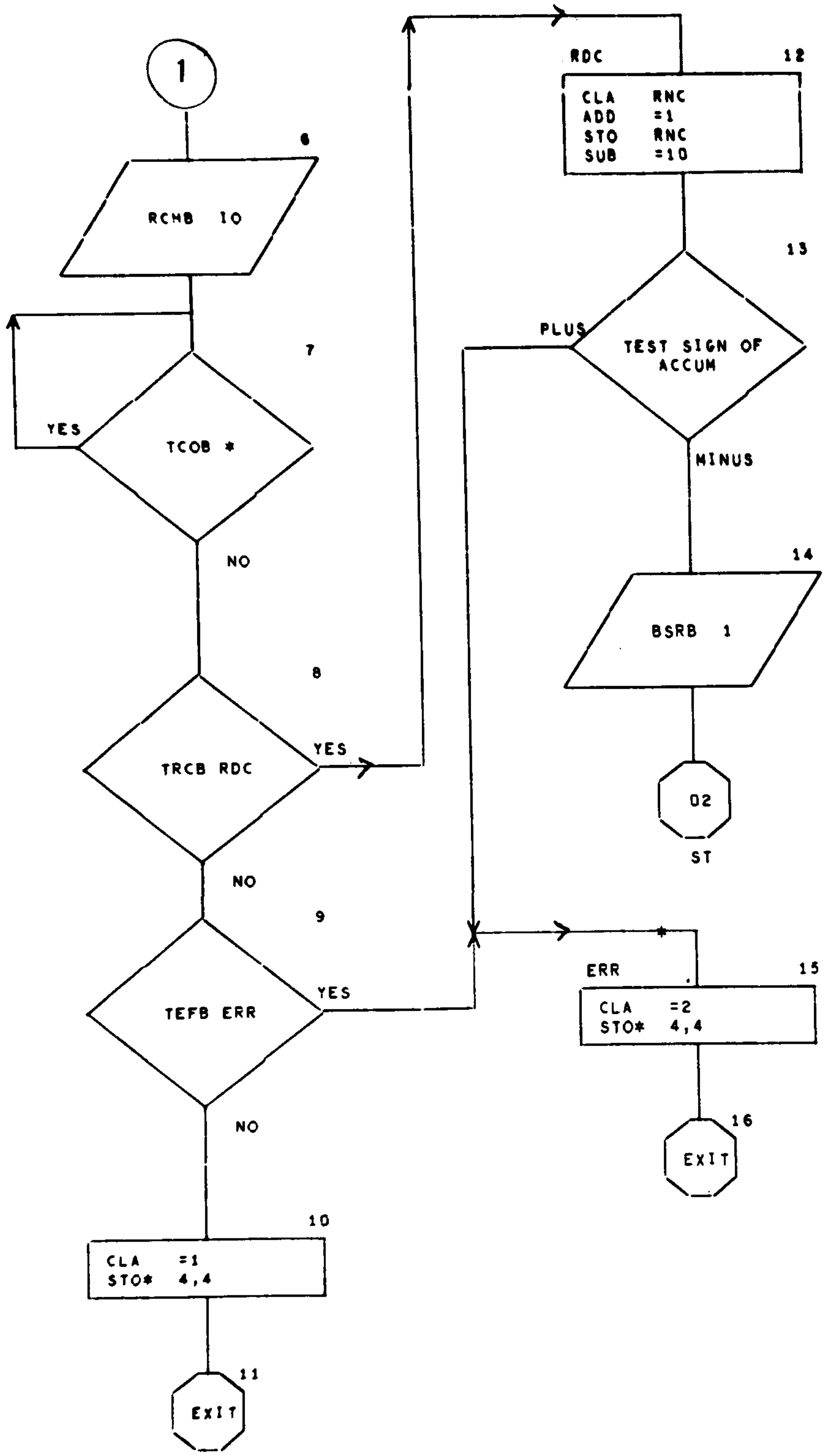
```
DECK RDB

          ENTRY   RDBIN
     IO   IOCD    *,,100
```

DECK DATAD

DECK RDB

26.01	RDBIN	1.22*	
26.02	ST	26.02	26.14
26.04		26.03	
26.05		26.04	
26.07		26.07	
26.12	RDC	26.08	
26.15	ERR	26.09	26.13
26.17	RNC		


RDBIN
1.22
1
STZ RNC
CLA 3,4
STA 10
ST
2
YES
TCOB *
NO
3
YES
TRCB *+1
NO
4
YES
TEFB *+1
NO
5
RTBB 1
1
RNC
17
HALT
18
EXIT


1
6
RCHB IO
7
TCOB *
YES
NO
8
TRCB RDC
YES
NO
9
TEFB ERR
YES
NO
10
CLA =1
STO* 4,4
11
EXIT
RDC
12
CLA RNC
ADD =1
STO RNC
SUB =10
13
TEST SIGN OF ACCUM
PLUS
MINUS
14
BSRB 1
02
ST
ERR
15
CLA =2
STO* 4,4
16
EXIT

XII. REFERENCES

1. SLOPE - A Digital Computer Program for Solar and Lunar Orbit Perturbation Effects written for NASA Goddard Space Flight Center, Greenbelt, Maryland, by Westinghouse Defense and Space Center Aerospace Division, Baltimore, Maryland (Contract NAS 9753-8) under the direction of James P. Murphy, Isabella J. Cole and Theodore L. Felsentreger.

2. Murphy, James P. and Theodore L. Felsentreger, "Analysis of Lunar and Solar Effects on the Motion of Close Earth Satellites," NASA Technical Note D-3559, August 1966.